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(54) **METHOD AND APPARATUS OF REQUESTING CHANNEL ACCESS IN WIRELESS LOCAL AREA NETWORK**

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CPC ***H04W 74/0816*** (2013.01); *H04W 16/14* (2013.01)

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CPC H04W 76/02; H04W 72/0453; H04W 72/0413; H04L 43/0882
USPC 370/330; 455/450
See application file for complete search history.

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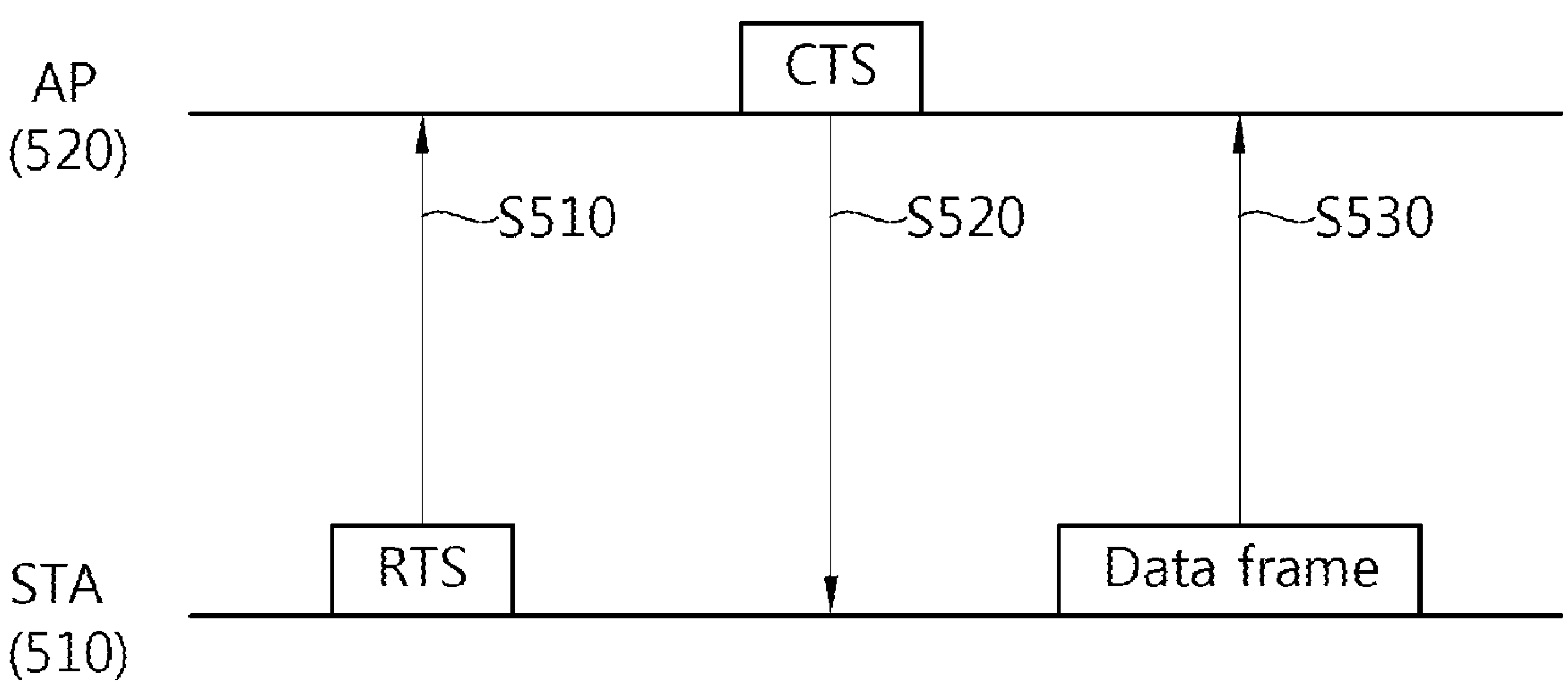
(57) **ABSTRACT**

A method and apparatus of requesting a channel access in a wireless local area network is provided. A transmitter transmits a plurality of Request To Send (RTS) frames over a plurality of requesting channels and receives at least one Clear To Send (CTS) frame over at least one responding channel as a response for the plurality of RTS frames. Each of the plurality of RTS frames indicates a bandwidth for the plurality of requesting channels, and the at least one CTS frame indicates a bandwidth for the at least one responding channel.

24 Claims, 19 Drawing Sheets



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H04W 16/14 (2009.01)

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FIG. 1

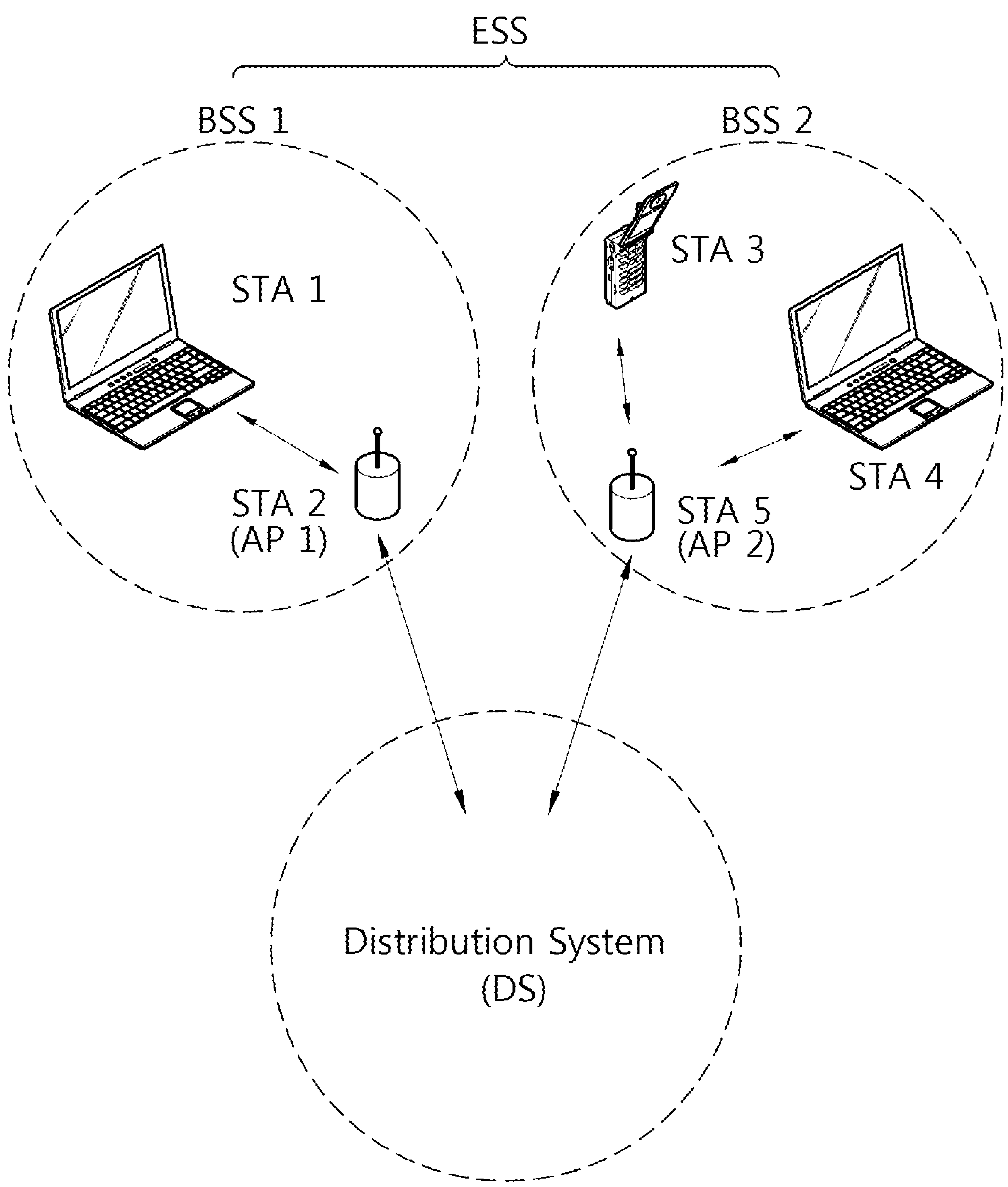

ESS
BSS 1
BSS 2
STA 1
STA 3
STA 2
(AP 1)
STA 5
(AP 2)
STA 4
Distribution System
(DS)

FIG. 2

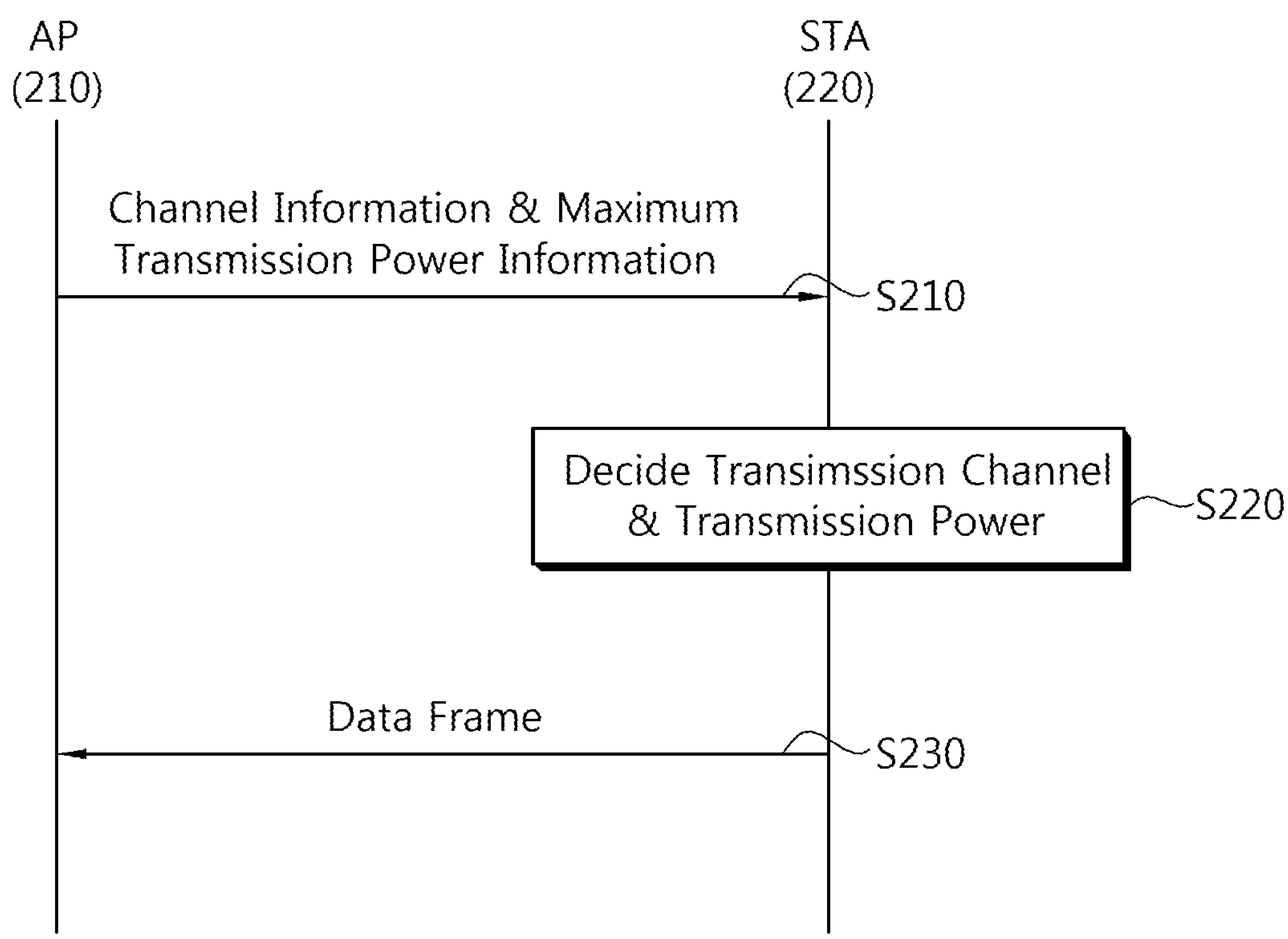

AP
(210)
STA
(220)
Channel Information & Maximum
Transmission Power Information
S210
Decide Transimssion Channel
& Transmission Power
S220
Data Frame
S230

FIG. 3

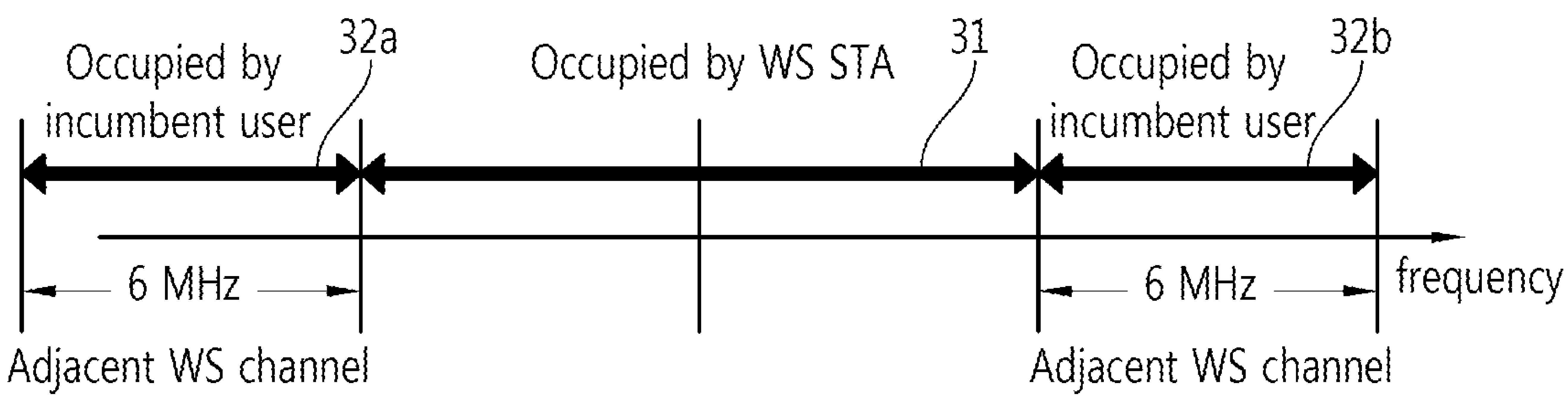
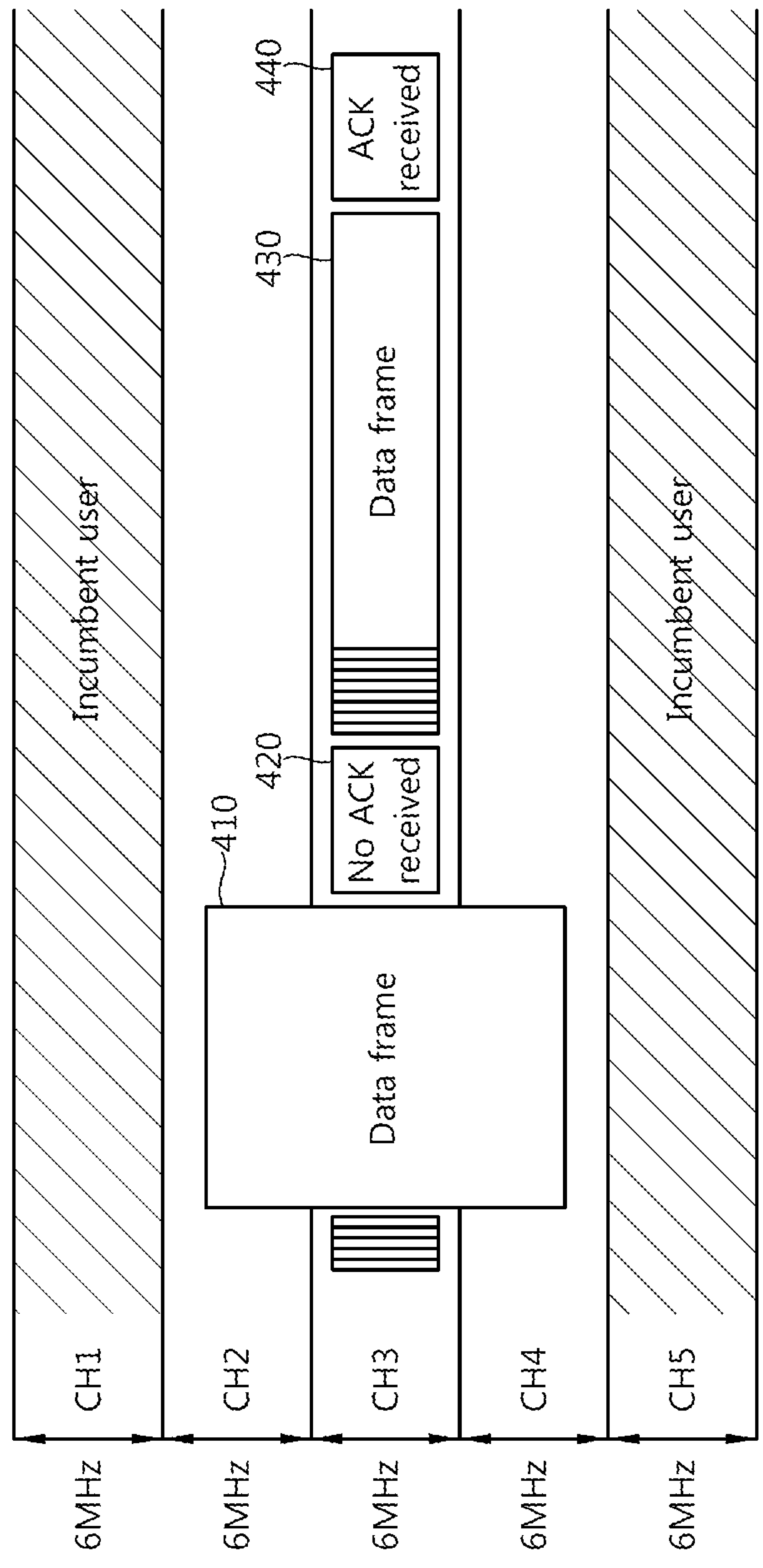

Occupied by incumbent user
32a
Occupied by WS STA
31
Occupied by incumbent user
32b
6 MHz
frequency
6 MHz
Adjacent WS channel
Adjacent WS channel

FIG. 4



CH1
CH2
CH3
CH4
CH5
6MHz
6MHz
6MHz
6MHz
6MHz
Incumbent user
Incumbent user
Data frame
410
No ACK received
420
Data frame
430
ACK received
440

FIG. 5

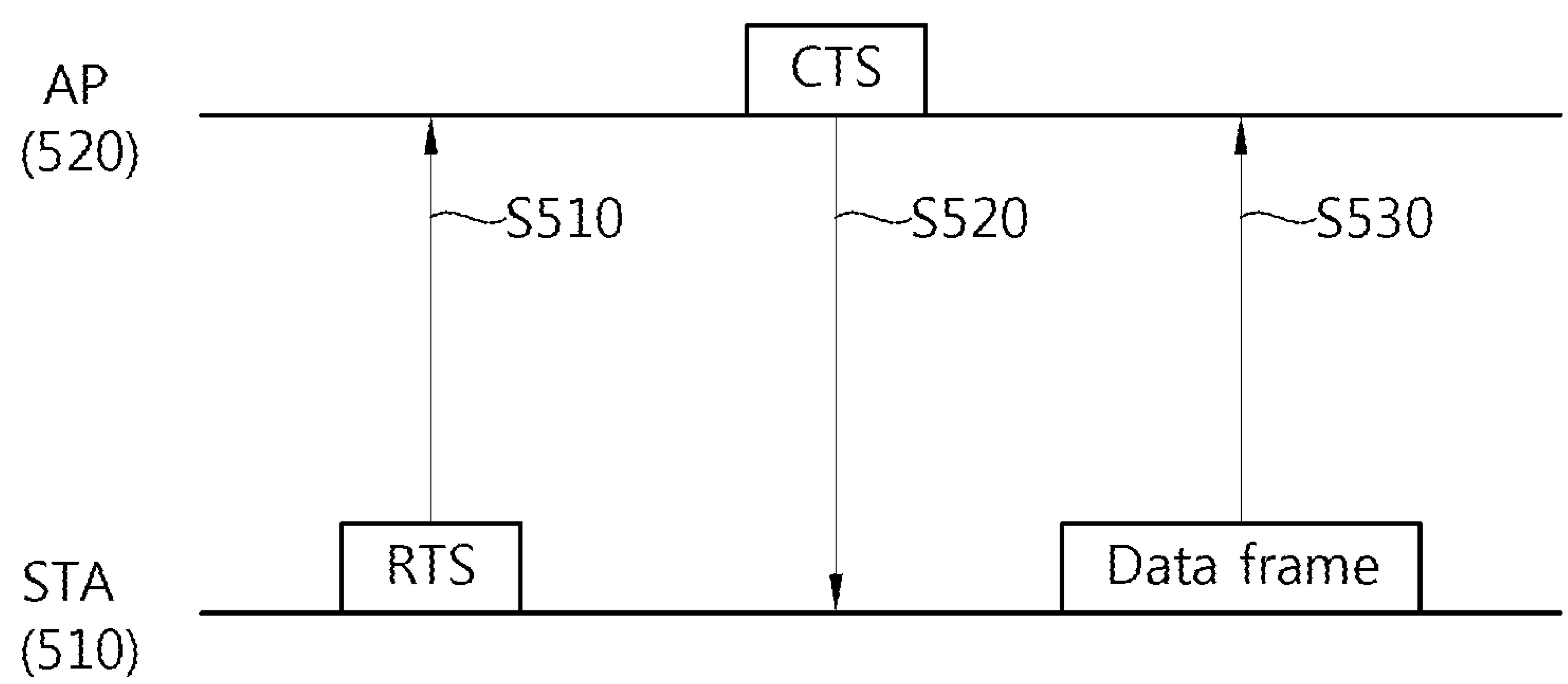


FIG. 6

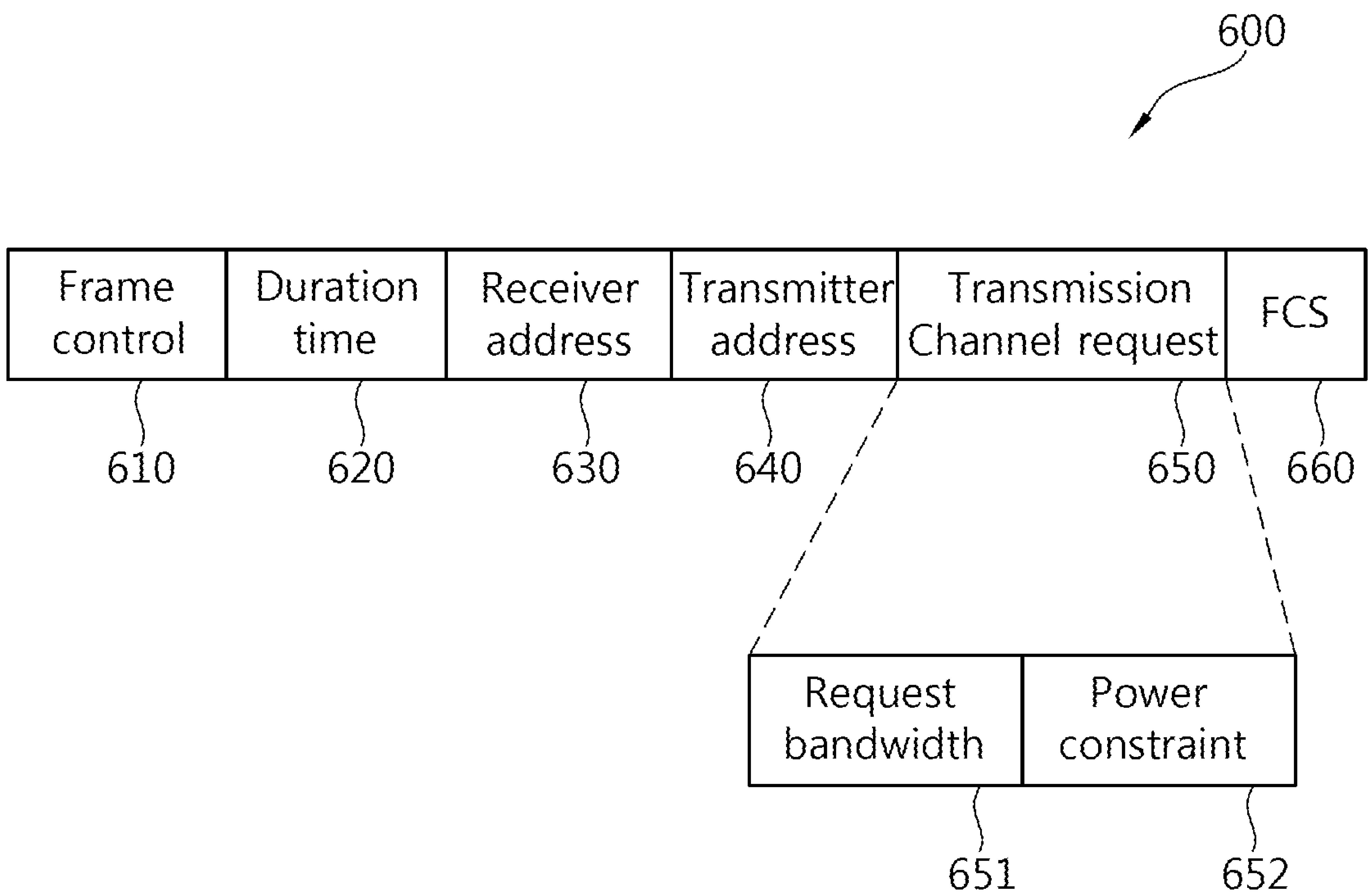

600
Frame control
Duration time
Receiver address
Transmitter address
Transmission Channel request
FCS
610
620
630
640
650
660
Request bandwidth
Power constraint
651
652

FIG. 7

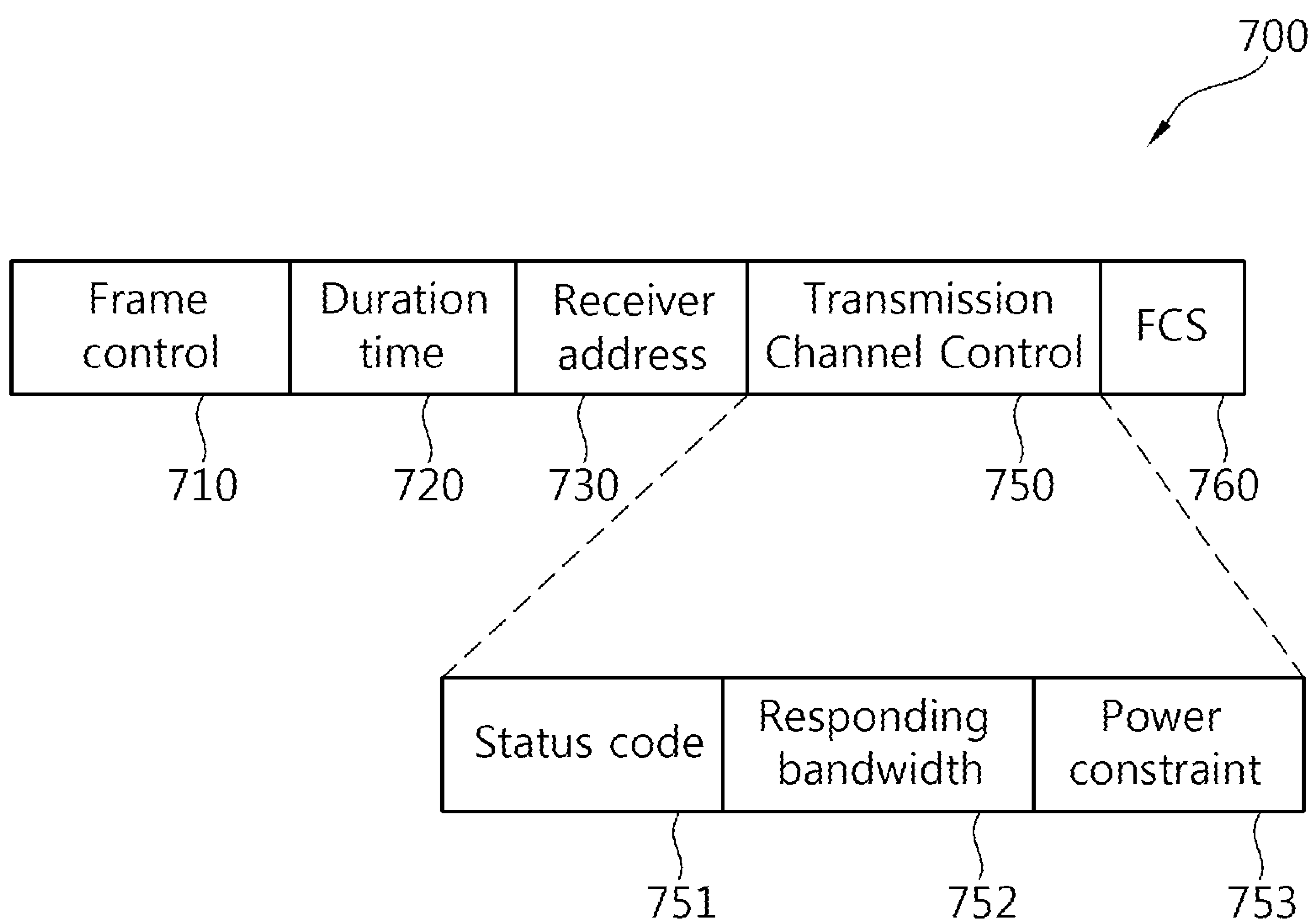

700
Frame control
Duration time
Receiver address
Transmission Channel Control
FCS
710
720
730
750
760
Status code
Responding bandwidth
Power constraint
751
752
753

FIG. 8

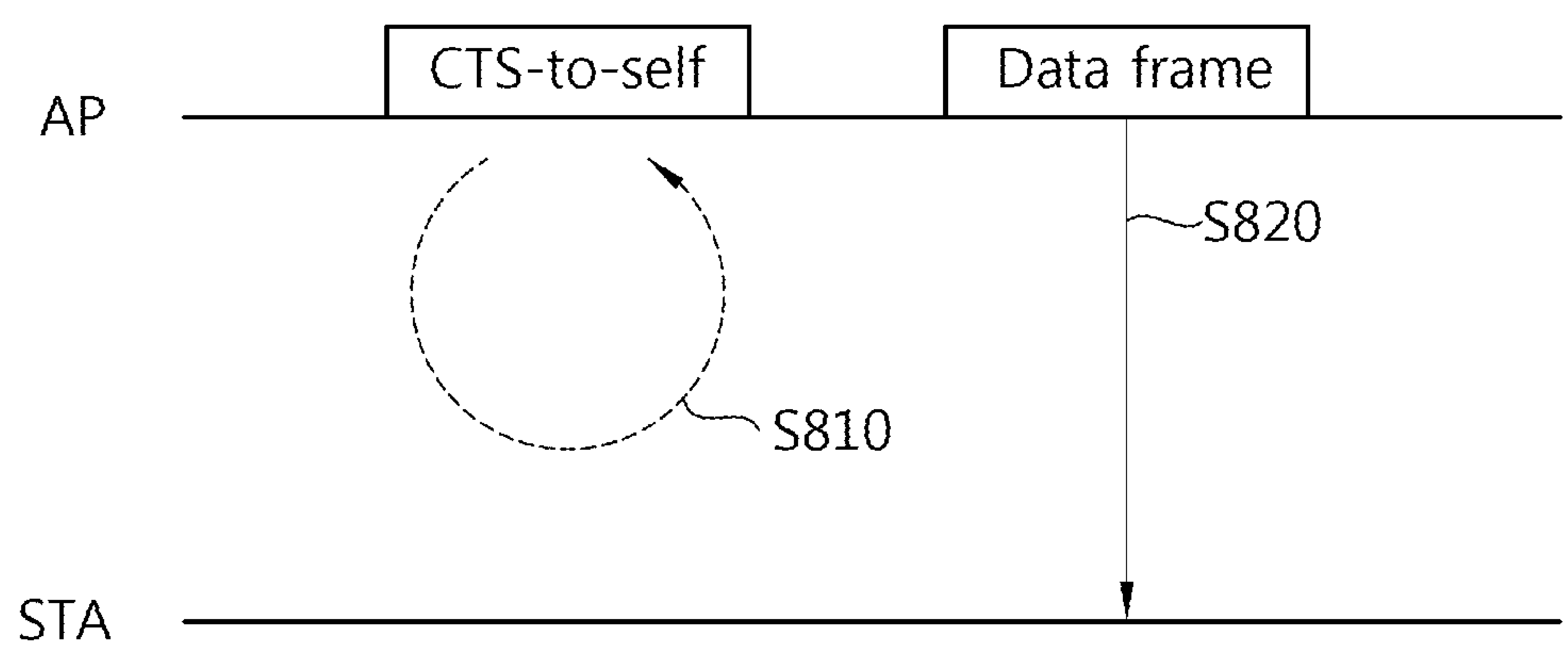


FIG. 9

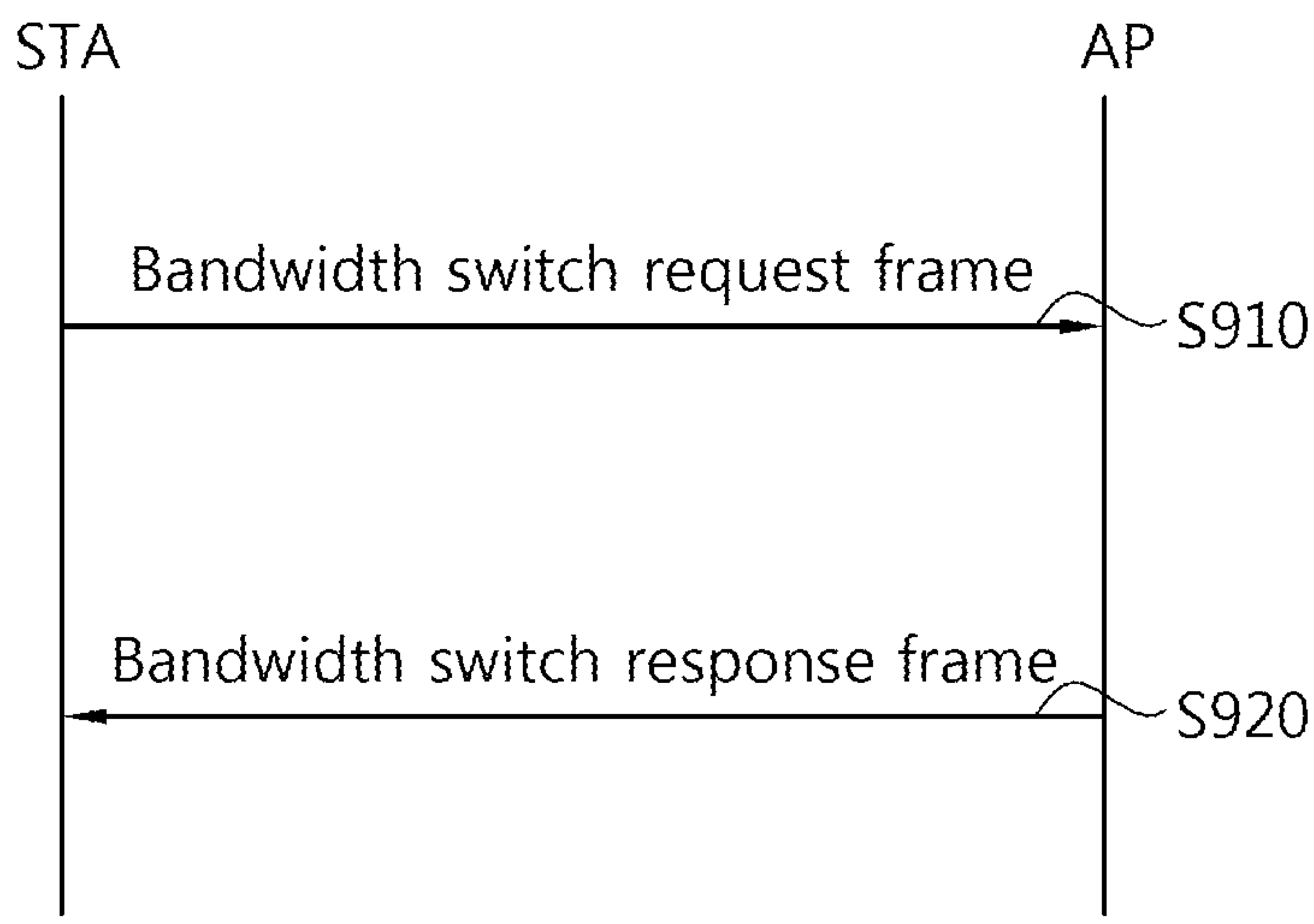

STA
AP
Bandwidth switch request frame
S910
Bandwidth switch response frame
S920

FIG. 10

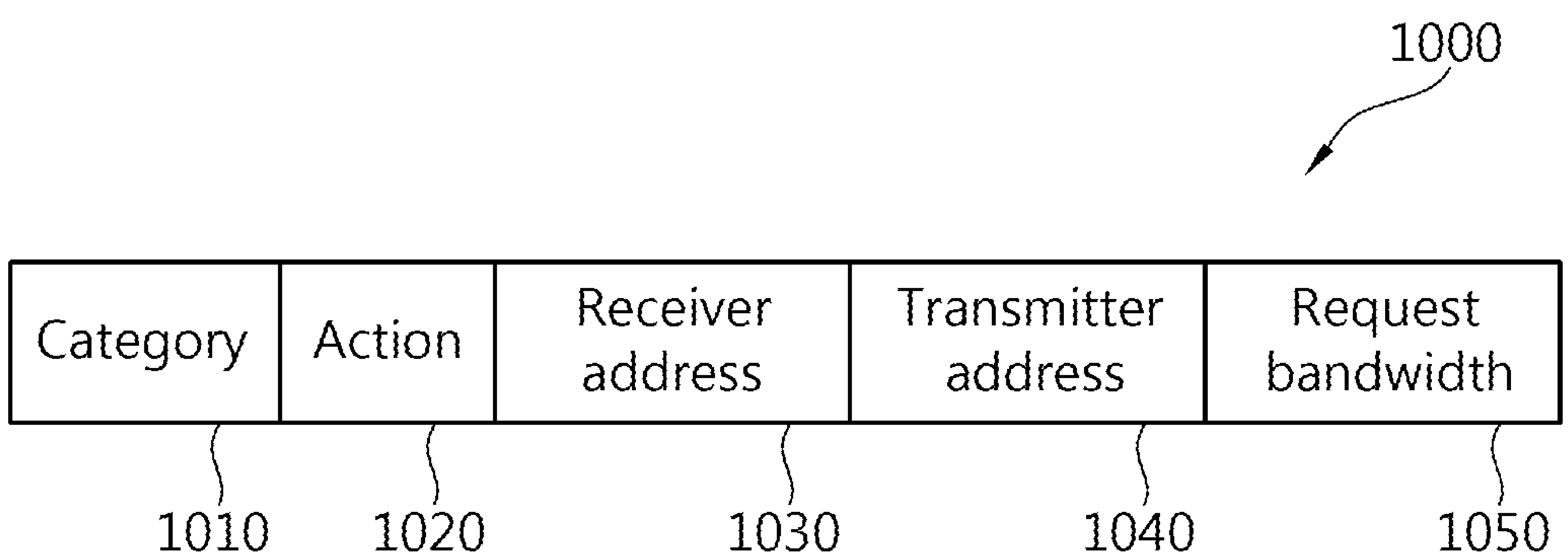

1000
Category
Action
Receiver address
Transmitter address
Request bandwidth
1010
1020
1030
1040
1050

FIG. 11

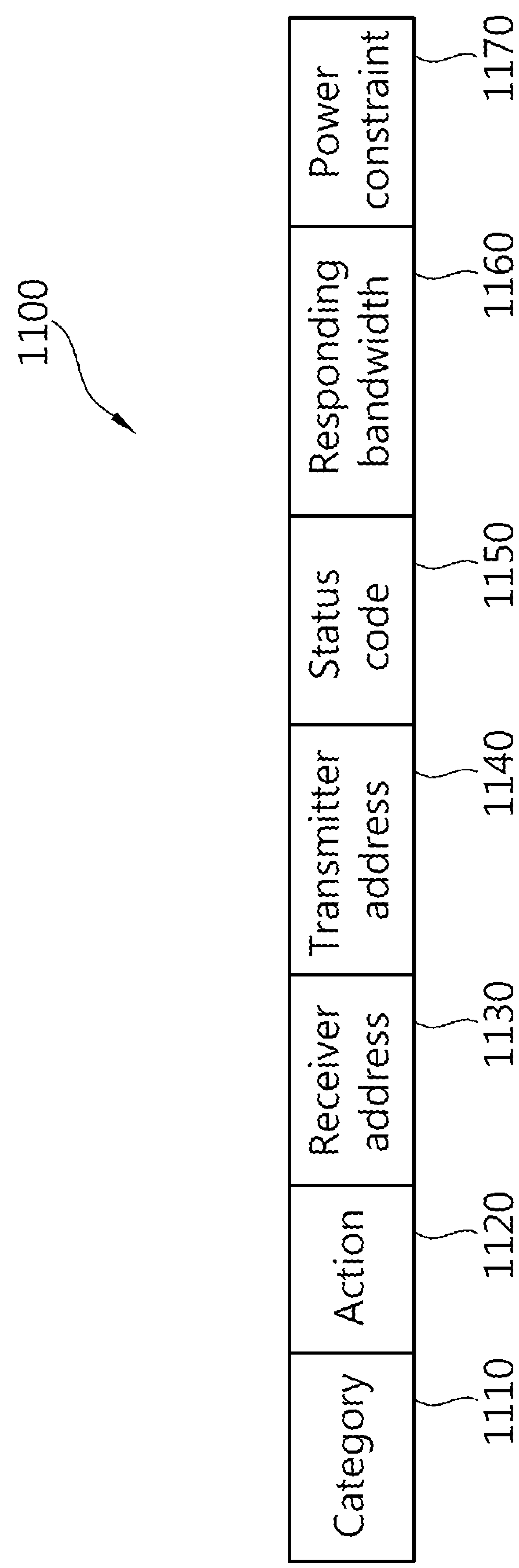

1100
Category
Action
Receiver address
Transmitter address
Status code
Responding bandwidth
Power constraint
1110
1120
1130
1140
1150
1160
1170

FIG. 12

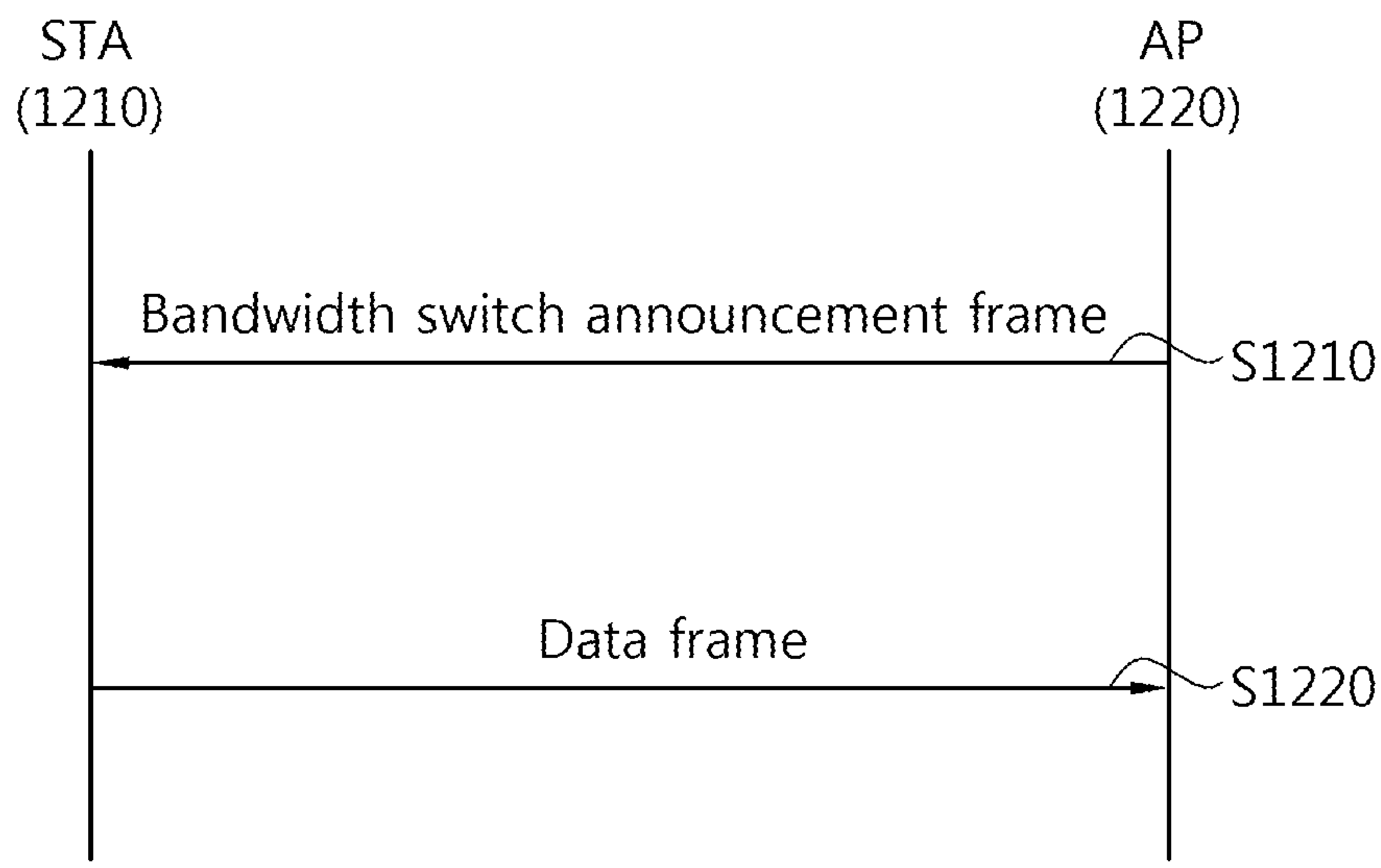

STA
(1210)
AP
(1220)
Bandwidth switch announcement frame
S1210
Data frame
S1220

FIG. 13

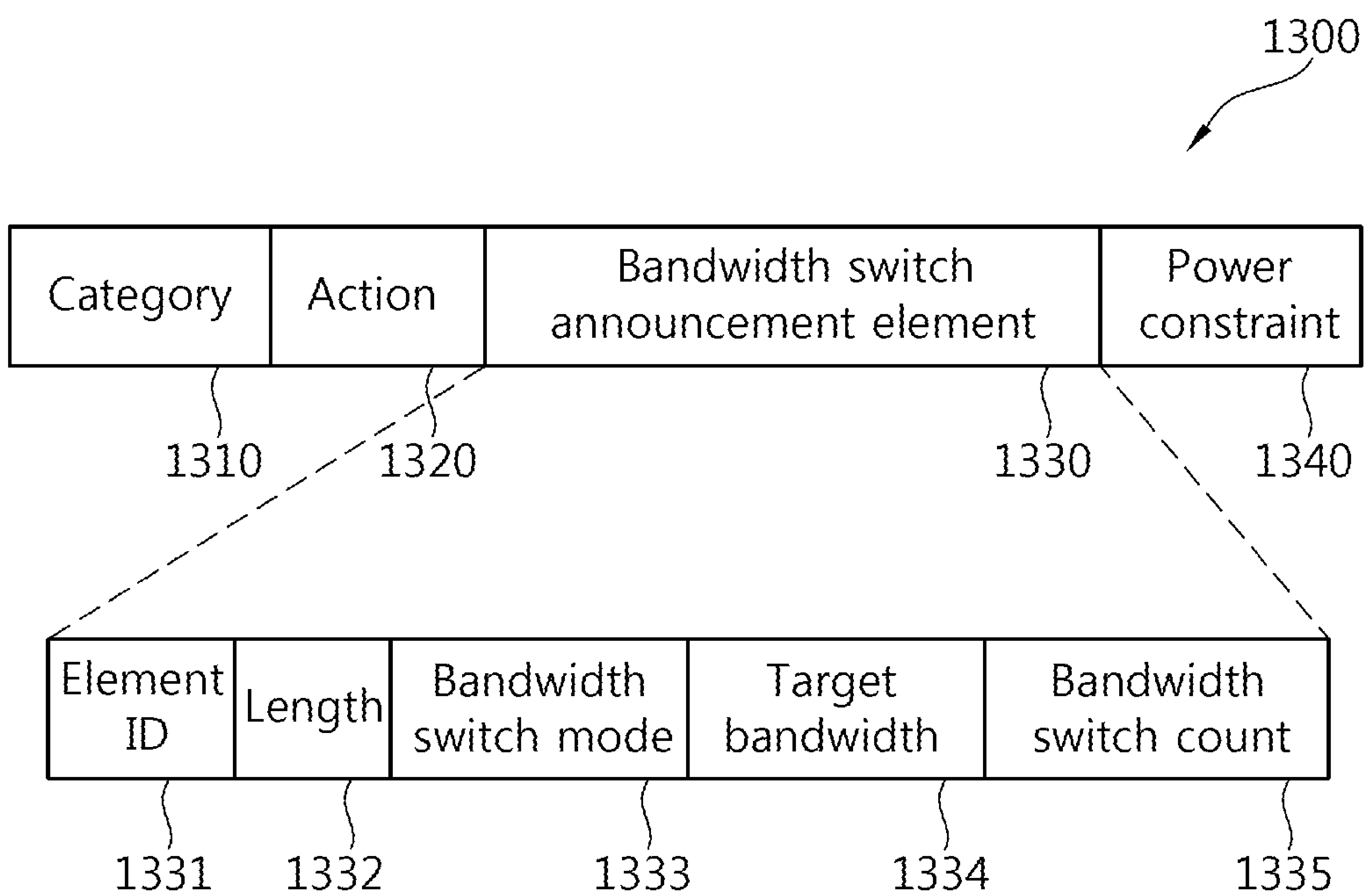

1300
Category
Action
Bandwidth switch announcement element
Power constraint
1310
1320
1330
1340
Element ID
Length
Bandwidth switch mode
Target bandwidth
Bandwidth switch count
1331
1332
1333
1334
1335

FIG. 14

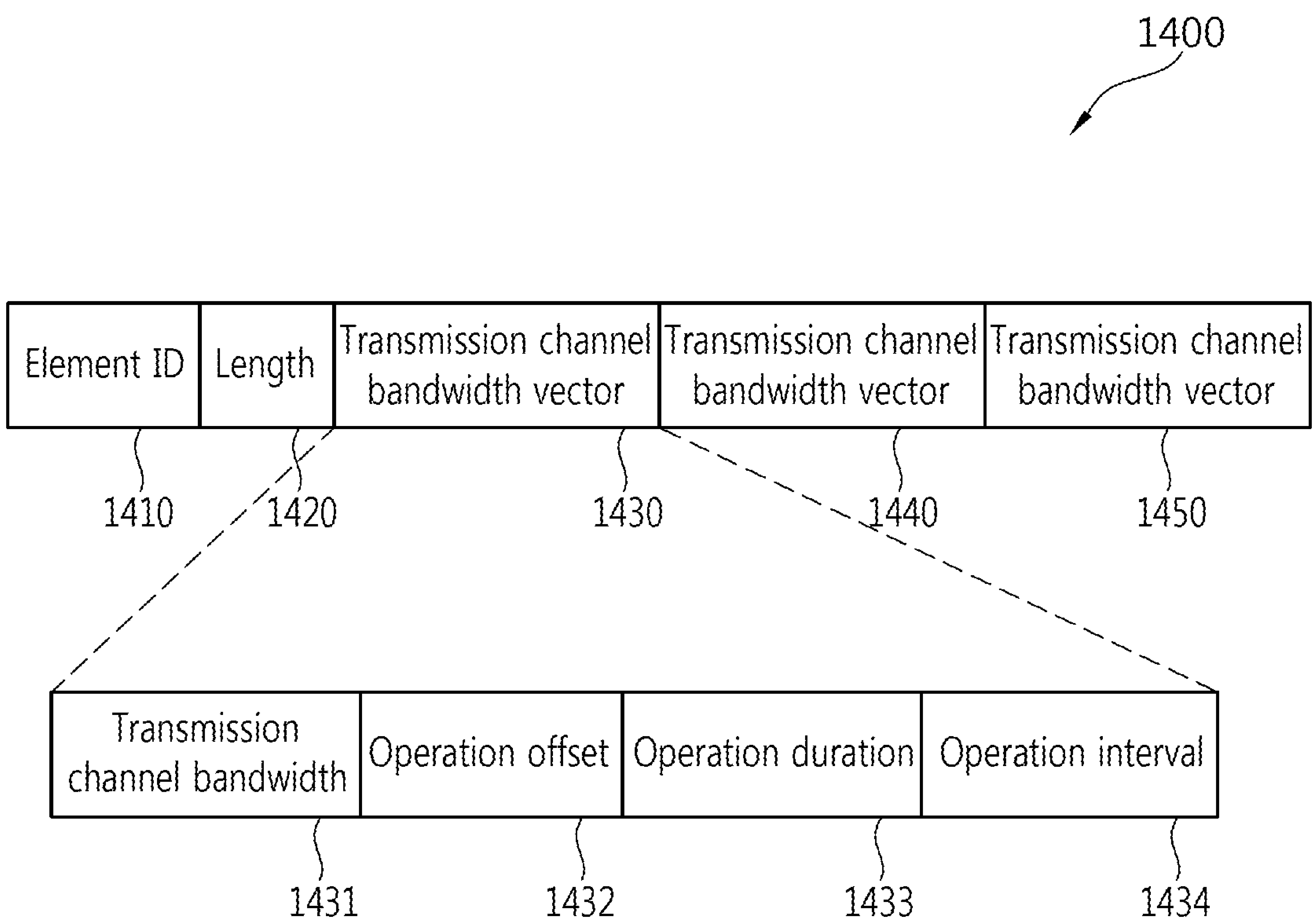

1400
Element ID
Length
Transmission channel bandwidth vector
Transmission channel bandwidth vector
Transmission channel bandwidth vector
1410
1420
1430
1440
1450
Transmission channel bandwidth
Operation offset
Operation duration
Operation interval
1431
1432
1433
1434

FIG. 15

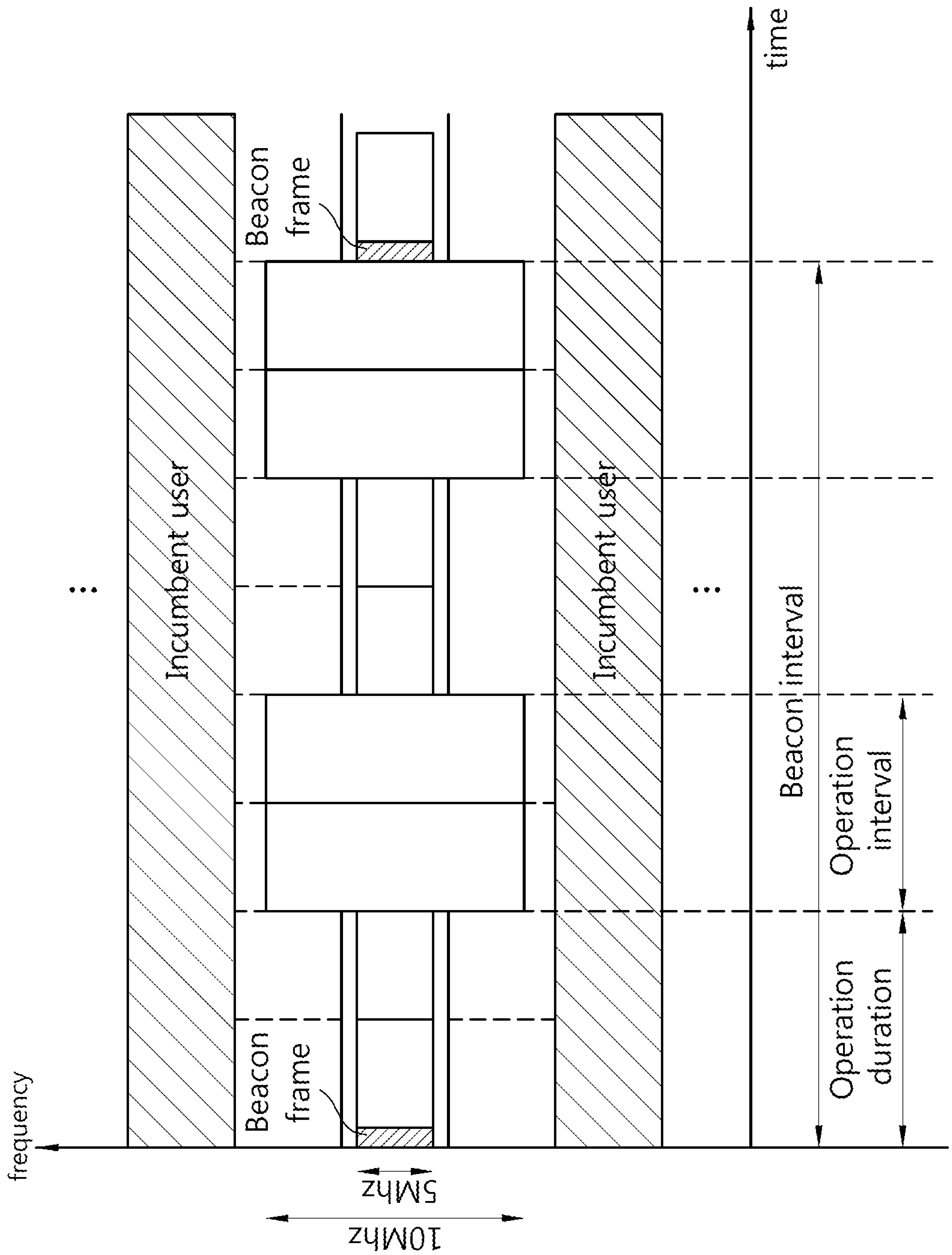

time
frequency
Incumbent user
Incumbent user
Beacon frame
Beacon frame
Beacon interval
Operation interval
Operation duration
5Mhz
10Mhz

FIG. 16

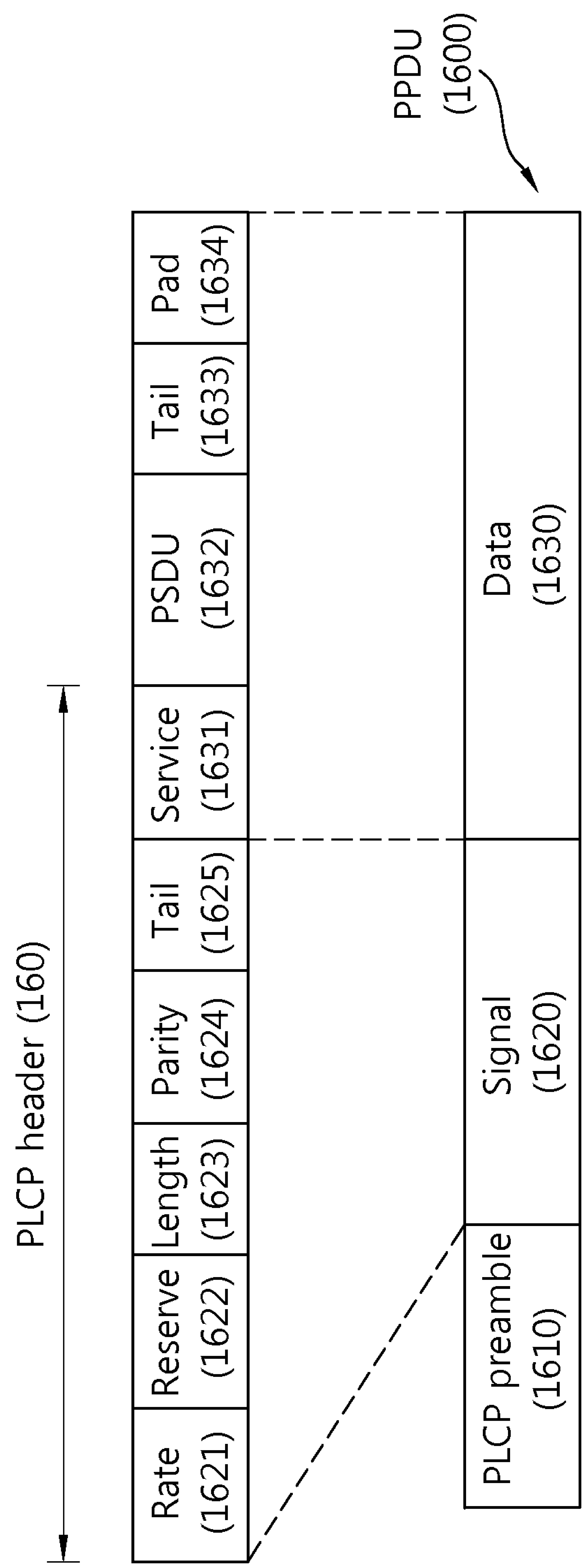

PPDU
(1600)
PLCP header (160)
Rate
(1621)
Reserve
(1622)
Length
(1623)
Parity
(1624)
Tail
(1625)
Service
(1631)
PSDU
(1632)
Tail
(1633)
Pad
(1634)
PLCP preamble
(1610)
Signal
(1620)
Data
(1630)

FIG. 17

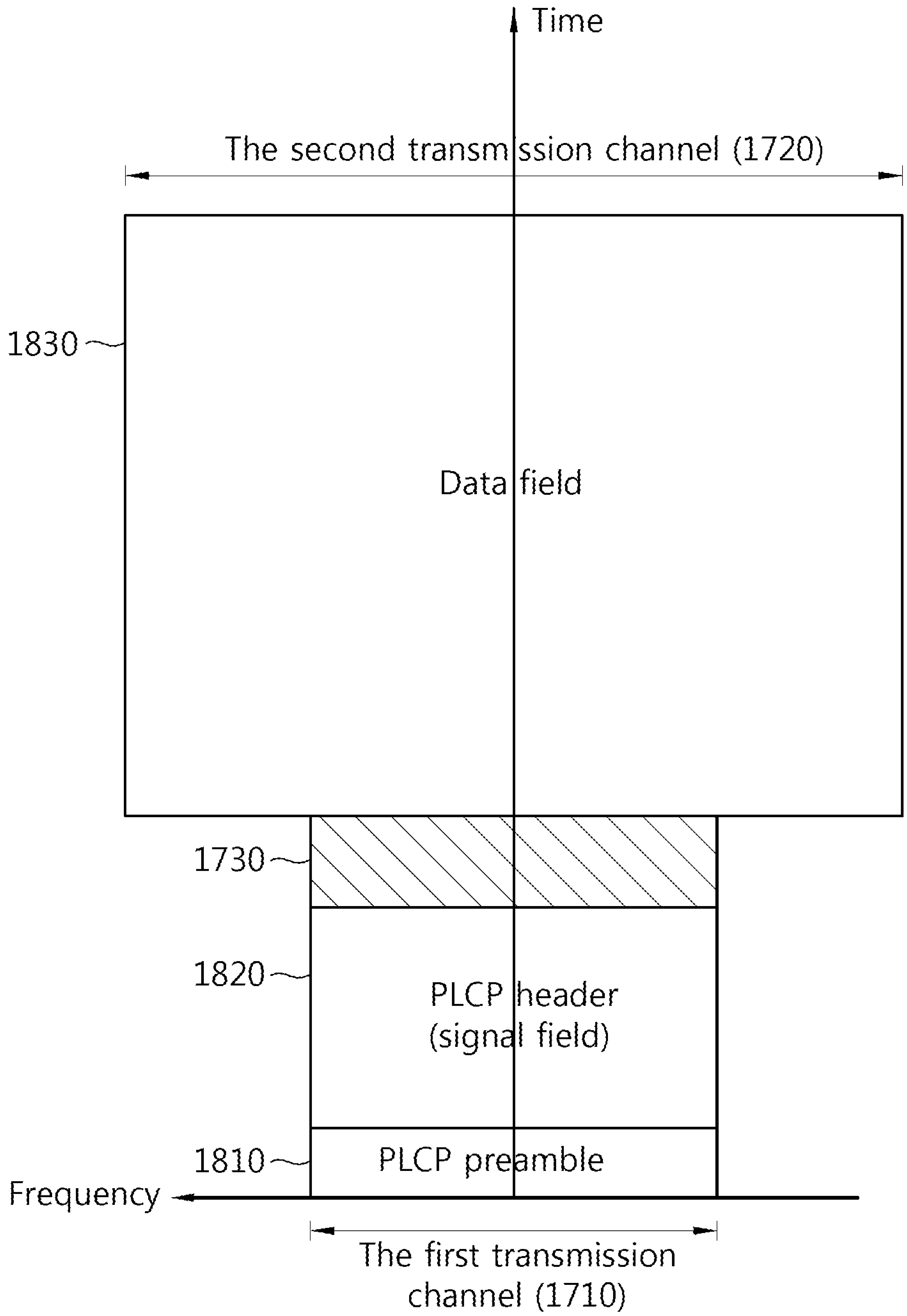

Time
The second transmission channel (1720)
1830
Data field
1730
1820
PLCP header
(signal field)
1810
PLCP preamble
Frequency
The first transmission
channel (1710)

FIG. 18

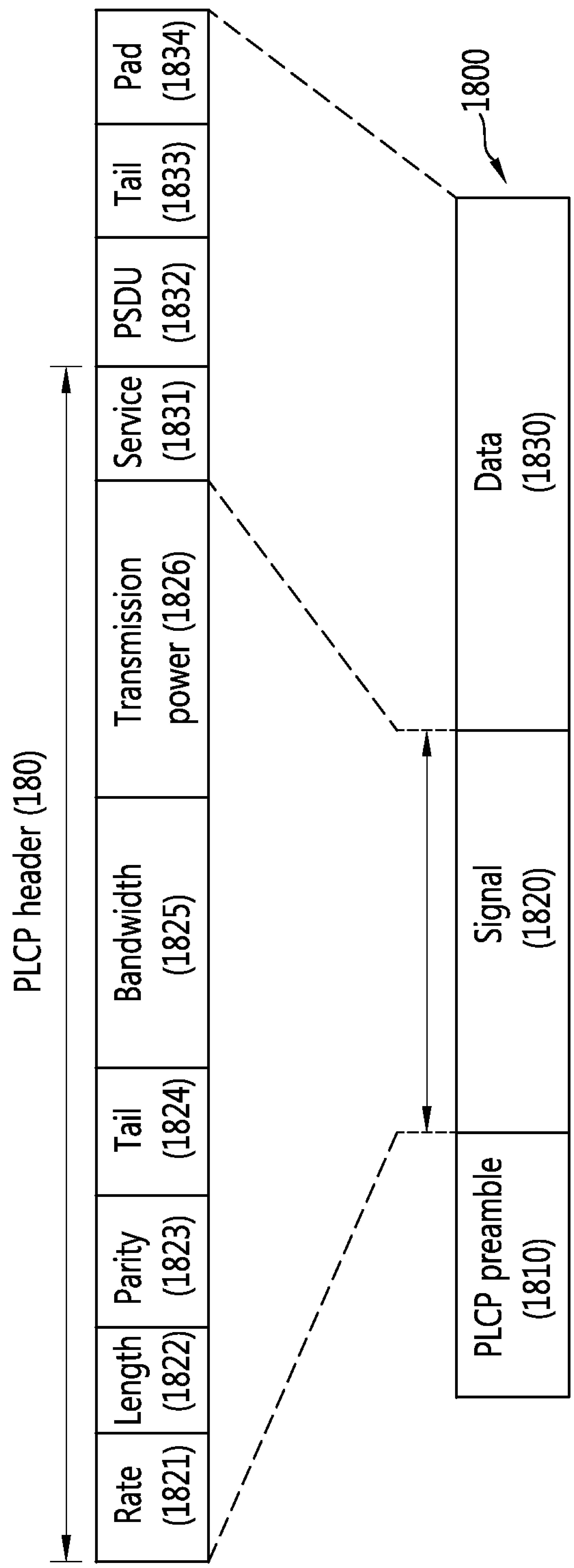
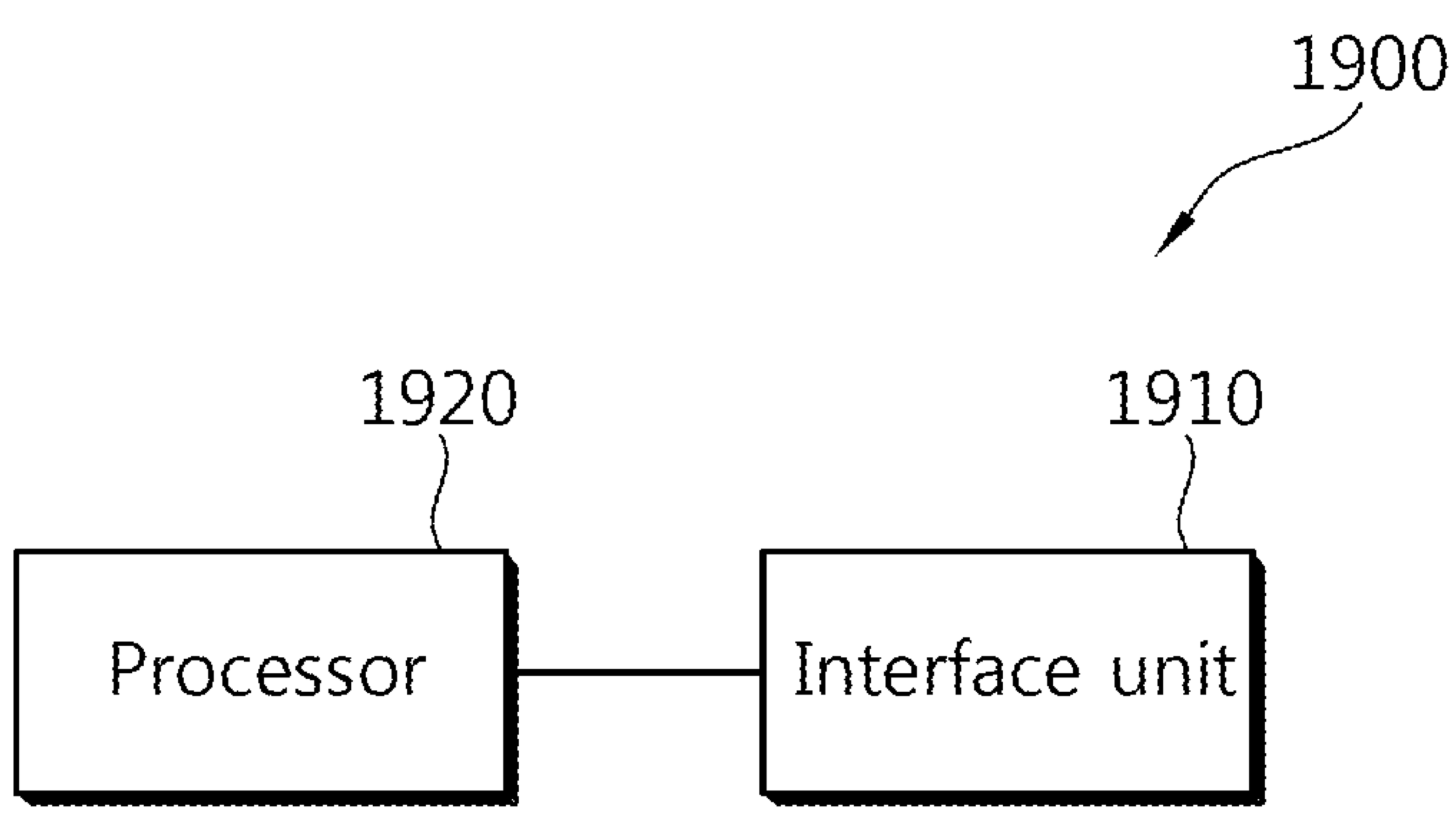

1800
PLCP preamble (1810)
Signal (1820)
Data (1830)
PLCP header (180)
Rate (1821)
Length (1822)
Parity (1823)
Tail (1824)
Bandwidth (1825)
Transmission power (1826)
Service (1831)
PSDU (1832)
Tail (1833)
Pad (1834)

FIG. 19



METHOD AND APPARATUS OF REQUESTING CHANNEL ACCESS IN WIRELESS LOCAL AREA NETWORK

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority of U.S. Provisional applications 61/302,552 filed on Feb. 9, 2010, 61/303,289 filed on Feb. 10, 2010, 61/305,545 filed on Feb. 18, 2010, and Korean Patent Applications No. 10-2010-0084795 filed on Aug. 31, 2010, all of which are incorporated by reference in their entirety herein.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to wireless communications, and more particularly, to a method and apparatus for requesting a channel access in a wireless local area network.

2. Related Art

With recent development of information and communications technology, various wireless communications technology has been developed. Among them, a wireless local area network (WLAN) is technology that allows portable user equipment such as a personal digital assistant (PDA), a laptop computer, a portable multimedia player (PMP), etc. in a home, an enterprise or a certain service providing zone to have wireless access to high-speed Internet on the basis of radio frequency technology.

It is presupposed that communications in the WLAN based on institute of electrical and electronics engineers (IEEE) 802.11 standards are performed within a zone called a basic service set (BSS). The BSS zone has a somewhat indefinite boundary since it may vary depending on propagating characteristics of a wireless medium. Such a BSS is basically divided into two configurations of an independent BSS (IBSS) and an infrastructure BSS. The former indicates a BSS that forms a self-contained network and does not allows access to a distribution system (DS), and the latter indicates a BSS that includes one or more access points (AP), a distribution system, etc. and generally employs the AP in all communications including communication between stations.

The station (STA) having desire to access a wireless network may use two scanning methods for searching an accessible wireless network (BSS or IBSS), i.e., a candidate AP or the like.

One is passive scanning, which uses a beacon frame transmitted from the AP (or STA). That is, the STA having desire to access a wireless network periodically receives the beacon frames from the AP or the like managing a relevant BSS (or IBSS), thereby finding the accessible BSS or IBSS.

The other is active scanning. The STA having desire to access the wireless network first transmits a probe request frame. Then, the STA or AP that receives the probe request frame responds with a probe response frame.

TV Whitespace includes channels allocated to broadcast TV, which are permitted to be used by cognitive radio device. TV White Space may include UHF band and VHF band. The spectrum (hereinafter, can be called as 'White Space') not used by a licensed device can be used by an unlicensed device. The frequency band permitted to be used by unlicensed device can be differently defined for each country. Generally, this frequency band comprises 54-698 MHz (US, Korea), and some of this frequency band can't be used for the unlicensed device. Here, 'licensed device ' means a device of the user permitted in this frequency band, and can be differently called as 'primary user', or 'incumbent user'. The unlicensed device, which wishes to use the TV White Space (TVWS), shall acquire information for available channel list at its location.

An unlicensed device should provide a protection mechanism for the incumbent user. That is, the unlicensed device should stop using a specific channel, when an incumbent user, such as wireless microphone, is using that specific channel. For this purpose, spectrum sensing mechanism is required. Spectrum sensing mechanism comprises Energy Detection scheme, Feature Detection scheme, etc. By using this mechanism, unlicensed device determines that the channel is used by an incumbent user, when the strength of the primary signal is greater than a predetermined level, or when Digital Television (DTV) Preamble is detected. And, the unlicensed device (station or access point) shall lower its transmit power, when it is detected that the neighboring channel, next to the channel used by the unlicensed device, is used by the incumbent user.

On the other hand, in order to efficiently operate the unlicensed device on TVWS, more discussion is needed on an enabling mechanism of letting the unlicensed device to operate in TVWS, how efficiently the unlicensed device finds the network to be connected, how the information for the available channel in TVWS is efficiently acquired, efficient format of that information, and efficient signaling mechanism to exchange this information, etc.

SUMMARY OF THE INVENTION

A method and apparatus for requesting a channel access in a wireless local area network is provided.

Also method and apparatus for bandwidth a adaptation in a wireless local area network is also provided.

In an aspect, a method of requesting a channel access in a wireless local area network is provided. The method includes transmitting, by a transmitter to a receiver, a plurality of Request To Send (RTS) frames over a plurality of requesting channels, each of the plurality of RTS frames including a receiver address field and a transmitter address field, the receiver address field indicating an address of the receiver, the transmitter address field indicating an address of the transmitter, and receiving, by the transmitter from the receiver, at least one Clear To Send (CTS) frame over at least one responding channel as a response for the plurality of RTS frames, the at least one CTS frame including a receiver address field indicating the address of the transmitter, wherein each of the plurality of RTS frames indicates a bandwidth for the plurality of requesting channels, and the at least one CTS frame indicates a bandwidth for the at least one responding channel.

Each of the plurality of RTS frames may be transmitted over each of the plurality of requesting channels.

The at least one responding channel may be selected among the plurality of requesting channels.

If at least one requesting channel among the plurality of requesting channels is idle before receiving at least one RTS frame, the at least one requesting channel may be selected as the at least one responding channel.

The bandwidth for the at least one responding channel may be narrower than the bandwidth for the plurality of requesting channels.

The bandwidth for the plurality of RTS frames may be one of 20 MHz, 40 MHz, 80 MHz and 160 MHz.

Each of the plurality of RTS frames may include a duration time field indicating a time required to transmit data and the at least one CTS frame may include a duration time field indicating a time required to transmit the data.

In another aspect, a transmitter of requesting a channel access in a wireless local area network is provided. The transmitter includes an interface unit providing a wireless interface, and a processor operatively coupled with the interface unit and configured for transmitting, to a receiver, a plurality of Request To Send (RTS) frames over a plurality of requesting channels, each of the plurality of RTS frames including a receiver address field and a transmitter address field, the receiver address field indicating an address of the receiver, the transmitter address field indicating an address of the transmitter, and receiving, from the receiver, at least one Clear To Send (CTS) frame over at least one responding channel as a response for the plurality of RTS frames, the at least one CTS frame including a receiver address field indicating the address of the transmitter, wherein each of the plurality of RTS frames indicates a bandwidth for the plurality of requesting channels, and the at least one CTS frame indicates a bandwidth for the at least one responding channel.

By exchanging a RTS frame and CTS frame, bandwidth adaptation is performed. Before accessing channels, channels to minimize interference can be selected.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a wireless local area network(WLAN) system to implement the present invention.

FIG. **2** is a flowchart showing a method of regulating transmission power according to an exemplary embodiment of the present invention.

FIG. **3** shows an example of using a channel in a TV WS band.

FIG. **4** shows an example of a WLAN communication according to an exemplary embodiment of the present invention.

FIG. **5** is a flowchart showing a method of requesting a channel access according to an exemplary embodiment of the present invention.

FIG. **6** shows the format of the RTS frame used in the exemplary embodiment of FIG. **5** by way of example.

FIG. **7** shows the format of the CTS frame used in the exemplary embodiment of FIG. **5** by way of example.

FIG. **8** shows a data frame transmitting method according to another exemplary embodiment of the present invention.

FIG. **9** shows a data frame transmitting method according to still another exemplary embodiment of the present invention.

FIGS. **10** and **11** are block diagrams showing the formats of the bandwidth switch request frame and the bandwidth switch response frame.

FIG. **12** is a flowchart showing a bandwidth regulating method according to another exemplary embodiment of the present invention.

FIG. **13** is a block diagram showing the format of the bandwidth switch announcement frame used in the exemplary embodiment of FIG. **12**.

FIG. **14** shows an example of bandwidth management information included in the beacon frame.

FIG. **15** shows an example of operation that can be performed in an exemplary embodiment of the present invention.

FIG. **16** shows a format of a PPDU frame in the WLAN, which may refer to a paragraph 17.3.2 of "Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications" in IEEE P802.11-2007.

FIG. **17** shows a method of transmitting a data frame according to an exemplary embodiment of the present invention.

FIG. **18** is a block diagram showing the format of the PPDU frame according to an exemplary embodiment of the present invention.

FIG. **19** is a block diagram of a wireless device to implement the present invention.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

FIG. **1** shows a wireless local area network(WLAN) system to implement the present invention.

Referring to FIG. **1**, the WLAN system includes one or more basic service set (BSS). The BSS is a group of stations (STA) which can successfully synchronize and communicate with one another, and does not mean a certain zone.

An infrastructure BSS (BSS**1**, BSS**2**) includes one or more non-access point (AP) STAs (non-AP STA**1**, non-AP STA**2**, non-AP STA**2**); APs (AP STA**1**, AP STA**2**) providing distribution service; and a distribution system (DS) connecting the plurality of APs (AP STA**1**, AP STA**2**). In the infrastructure BSS, the AP manages the non AP STAs.

On the other hand, an independent BSS (IBSS) is a BSS that operates in an Ad-Hoc mode. Since the IBSS does not include the AP, there is no centralized management entity that performs centralized management. That is, in the IBSS, the non-AP STAs are managed in a distributed manner. In the IBSS, all STAs may be provided as mobile STAs and constitute a self-contained network since access to the DS is not allowed.

The STA is a predetermined functional medium having a medium access control (MAC) and a physical layer interface for a wireless medium, based on institute of electrical and electronics engineers (IEEE) 802.11 standards, which broadly includes both the AP and the non-AP STA.

The STA may be clled a mobile terminal, a wireless device, a wireless terminal, a mobile station(MS), a mobile subscriber unit, or the like.

The AP is a functional entity that provides access to the DS via a wireless medium for the STA associated with the AP. In the infrastructure BSS including the AP, communication between the non-AP STAs is basically performed via the AP, but direct communication between the non-AP STAs may be possible if a direct link is set. The AP may be also called a central controller, a base station (BS), a node-B, a base transceiver system (BTS), a cite controller, or the like.

The plurality of infrastructure BSSs may be connected to one another through the distribution system (DS). The plurality of BSSs connected through the DS is called an extended service set (ESS). The STAs included in the ESS can communicate with one another, and the non-AP STAs within one ESS can move from one BSS to another BSS while performing the communication without disconnection.

The DS is a mechanism that enables one AP to communicate with another AP. Through the DS, the AP can transmit a frame for the STAs associated with the BS managed by the AP, transmit a frame when one STA moves to another BSS, or transmit a frame to an external network such as a wired network or the like. The DS is not necessarily a network, but may be achieved without any limitation as long as it can provide predetermined distribution service based on IEEE 802.11. For example, the DS may be a wireless network such as a mesh network, or a physical structure connecting the APs with one another.

FIG. **2** is a flowchart showing a method of regulating transmission power according to an exemplary embodiment of the present invention.

Referring to FIG. **2**, the AP transmits the channel information and the maximum transmission power information to the STA (S**210**). On the basis of the information received from the AP, the STA determines the transmission channel and transmission power to be used and transmits the data frame to the AP (S**220**, S**230**).

The AP transmits information about the channel information and the maximum transmission power to the STA (S**210**). The channel information indicates an available channel as a channel that can be used by the STA to transmit the frame in the WLAN system. The channel information may indicate a number assigned to the channel or a frequency band used by the corresponding channel. The maximum transmission power information indicates the maximum transmission power available when transmitting the frame in the case where the STA uses the channel indicated by the channel information.

The channel information and the maximum transmission power may be continuously varied depending on frequency band environments. Accordingly, the AP may periodically update the relevant information, and transmit the updated information to the STA again. To update the channel information and the maximum transmission power information, the AP may directly ascertain whether the frequency band is occupied by another WLAN system or heterogeneous communication system. This may be achieved by sensing a signal transmitted from another wireless apparatus. Also, information about the occupied state of the frequency band may be acquired by accessing a database (DB) where the channel information or the maximum transmission power information is periodically updated.

The AP may send the STA a setup frame as an action frame containing the channel information and the maximum transmission power information. Also, the channel information and the maximum transmission power information may be transmitted as being contained in a probe response frame that the AP transmits to the STA in response to a probe request frame in an active scanning procedure.

The STA has to receive the periodically updated channel information and maximum transmission power information. Accordingly, the channel information and maximum transmission power information, transmitted from the AP to the STA, may be transmitted as being included in a beacon frame periodically transmitted from the AP to the STA in the WLAN system.

The STA, which receives the channel information and the maximum transmission power information, selects a certain channel as a transmission channel, and transmits a data frame within a range of a value indicated by the maximum transmission power information (S**220**, S**230**).

A master device may transmit the channel information and the maximum transmit power information to wireless devices (which is called as dependent devices). The master device may be an AP or a non-AP STA. The master device selects transmission channels and their maximum transmission powers based on a database.

The transmission channels and the maximum transmission powers may be different depending on the types of STA. Thus, the master device may send the type of service-target STA as well as the channel information and the maximum transmission power information.

A STA may perform sensing with regard to each channel of the TV WS band, or may request other STA to report a sensing result.

If the STA can access a database containing information related to a channel state of the TV WS band, the STA can acquire the channel information without performing spectrum sensing.

The STA grasps the state of each channel through the channel information, and switches to an available channel if a used channel is not available anymore as a licensed user appears. As necessary, the STA may previously set up a preliminary channel to be used when the used channel is not available anymore.

If a certain channel available for the STA is adjacent to a channel being occupied by the licensed user, interference may occur when the STA uses the certain channel.

FIG. **3** shows an example of using a channel in a TV WS band. In the TV WS, an unlicensed device such as an AP and a STA can generally use about 30 channels each of which has a bandwidth of 6 MHz. As a precondition for using these channels, a certain desired channel has not to be occupied by the licensed user.

Suppose that each of channels **32***a* and **32***b* being used by the licensed user has a bandwidth of 6 MHz. In the conventional IEEE 802.11a standard, since the STA supports at least one of 5 MHz, 10 MHz and 20 MHz, let the AP and the STA have a standard channel bandwidth of 5 MHz. Thus, the AP and the STA can support a channel bandwidth of 10 MHz or 20 MHz by regarding 5 MHz as the standard bandwidth, according to how many WS channels are successively unoccupied.

Here, a transmission channel refers to a physical wireless resource that is used by an unlicensed device for transmitting a frame or the like wireless signal in a certain frequency band.

Assume that the STA can use a central band **31** in the TV WS, the licensed user is using both adjacent channels **32***a* and **32***b* with regard to the central band **31**, and the central band **31** is a bandwidth of the transmission channel.

The STA has to decrease the transmission power of the transmission channel **31** if sensing a signal of the licensed user in the WS channels **32***a* and **32***b* adjacent to the transmission channel **31** being used by the STA. This is to reduce the interference with the licensed user. For example, the maximum transmission power of the STA is 100 mW, but the maximum transmission power may be limited to **40** through 50 mW when the adjacent WS channels **32***a* and **32***b* are being used by the licensed user. Because of the above, there is no need of directly associating a broader bandwidth of a transmission channel with a higher throughput in consideration of such transmission power constraint. In some cases, higher transmission power may be more effective instead of using a transmission channel having a relatively narrow bandwidth.

On the other hand, if the bandwidth is broad but the transmission power is low, the coverage is so relatively narrow that the intended receiver such as the WS STA and/or the WS AP cannot receive the frame and thus a hidden node problem may arise. Accordingly, if the intended receiver cannot receive the frame, there is needed a method of retransmitting the frame by increasing the transmission power or a method of transmitting the frame by regulating the proper frequency bandwidth and transmission power in accordance with an communication environment of the intended receiver.

To solve the foregoing problem, there will be proposed below a method of regulating the bandwidth of the transmission channel in accordance with the status of the frequency band available to the AP and/or the STA and whether the transmitted frame is successfully received or not. Further, a constrained value of the transmission power may be regulated in accordance with the bandwidth of the transmission channel.

In the following exemplary embodiment of the present invention, the bandwidths of the transmission channel available to the STA and/or the AP are 5 MHz, 10 MHz and 20 MHz, the normal maximum transmission power is 100 mW, and the constrained maximum transmission power is 40 mW, but not limited thereto. Also, a condition that the STA transmits a frame to the AP will be described by way of example for the convenience of description. Alternatively, the exemplary embodiment of the present invention may be applied to a condition that the AP transmits a frame to the STA or a condition that a plurality of WS STAs transmits frames in an independent BSS.

FIG. **4** shows an example of a WLAN communication according to an exemplary embodiment of the present invention.

Referring to FIG. **4**, the STA transmits a data frame **410** to the AP through three transmission channels CH**2**, CH**3** and CH**4**. Assume that the maximum transmission power is constrained to 40 mW since adjacent channels are occupied by an incumbent user.

If the WS AP normally receives the data frame **410**, an acknowledgement (ACK) frame is transmitted to the STA.

On the other hand, the AP may receive no data frame **410** because of the constrained transmission power. In other words, the data frame **410** may be missed during the transmission.

Due to the miss of the data frame **410**, the AP cannot transmit the ACK frame and thus the STA cannot receive the ACK frame (**420**).

If there is no ACK frame received from the AP for a certain period of time, the STA can retransmit the data frame (**430**). Before retransmitting the data frame, random backoff may be performed for a certain period of time in order to use the frequency band.

In the case of retransmitting the data frame, the data frame may be transmitted by increasing the transmission power so that the AP can receive it. However, to prevent interference with the incumbent user, the bandwidth of the transmission channel is decreased. That is, a channel CH**3** is used as the transmission channel except the channels CH**2** and CH**4** adjacent to the channels CH**1** and CH **5** occupied by the incumbent user.

If the frame is retransmitted through the channel CH**3**, the AP can receive the retransmitted data frame and transmit the ACK frame to the STA (**340**).

To mitigate the interference with the incumbent user and more efficiently use the WS band, the STA needs to flexibly regulate the bandwidth of the transmission channel. Also, there is required a method of regulating the transmission power as well as the bandwidth of the transmission channel.

The present exemplary embodiment of the present invention provides a mechanism of regulating the bandwidth of the transmission channel used by the STA for transmitting the data frame.

Further, the present exemplary embodiment of the present invention may be applied to a method of transmitting or retransmitting the data frame by regulating the transmission bandwidth and/or the transmission power.

FIG. **5** is a flowchart showing a method of requesting a channel access according to an exemplary embodiment of the present invention. The STA **510** transmits a request-to-send (RTS) frame to the AP **520** in order to request a channel access (S**510**).

The RTS frame may include a transmission channel request field that contains information about requesting channels which are the transmission channel to be used by the STA **510** for transmitting the data frame. Each RTS frame can be transmitted over each requesting channel. The transmission channel request field includes information about the bandwidth of the requesting channel, and may further include information about the maximum transmission power when using a bandwidth of a relevant requesting channel.

The bandwidth of the requesting channel may be determined on the basis of a result from sensing a frequency band, performed by the STA **510**, a database related to occupation of the incumbent user with regard to the relevant frequency band, or combination of the two sensing result and data base.

The AP **520** that receives the RTS frame determines whether requesting channel is available or not. A requesting channel can be available if the requesting channel is idle before receiving RTS frames. Or, requesting channel is available or not may be determined on the basis of a spectrum sensing result performed under an environment condition that priority over frequency occupation is given to an incumbent user.

The AP **520** transmits a clear to send (CTS) frame to the STA **510** in response to a request frame. The CTS frame may include a status code field that contains instruction information about whether to accept that the STA **510** uses the requesting channel bandwidth. In the case that the status code field instructs that the use of the requesting channel bandwidth is accepted, the STA **510** transmits the data frame to the AP **520** through the corresponding bandwidth.

CTS frame may include a field that contains responding information about a responding channel which is an available transmission channel. When the status code indicates that the requesting channel bandwidth is denied, information about a responding channel bandwidth may be include in CTS frame. Or, CTS frame may include information about transmission channel bandwidths which CTS frame can be transmitted over. The CTS frame can be transmitted in a bandwidth specified in the RTS frame. The responding channel can be among requesting channels. Accordingly, the bandwidth for the responding channel is narrower than the bandwidth for the requesting channels.

FIG. **6** shows the format of the RTS frame used in the exemplary embodiment of FIG. **5** by way of example.

The RTS frame **600** includes a frame control field **610** indicating a frame type, a duration time field **620** indicating time to use a wireless medium during the whole frame exchanging procedure, a receiver address field **630** indicating a medium access control (MAC) address of a wireless apparatus that receives the RTS frame **600**, and a frame check sequence (FCS) field **660** used for detection and correction of an error that occurs when transmitting and receiving the frame. A transmitter address **640** indicates an MAC address of a wireless apparatus that transmits the RTS frame.

The RTS frame **600** includes a transmission channel request **650** indicating information about the requesting channel desired to be used by the STA **510**. The transmission channel request field **650** may include a request bandwidth subfield **651** and a power constraint subfield **652**.

The request bandwidth subfield **651** indicates the bandwidth of the requesting channel desired to be used. For example, let the RTS frame be transmitted over 4 requesting channels. If the bandwidth of each requesting channel is 20 MHz, the request bandwidth subfield **651** indicates 80 MHz. In the IEEE 802.11 WLAN system, a channel available to the wireless apparatus has four values of 5 MHz, 10 MHz, 20 MHz or 40 MHz, so that the bandwidth subfield **651** can have the size of 2 bits. However, the size of the request bandwidth subfield **651** may vary depending on the bandwidth of the channel selectable by the wireless device. The AP **520** recognizes the bandwidth of the transmission channel indicated by the request bandwidth subfield **651** of the RTS frame **600** as a bandwidth desired to be used by the STA **510**, and thus determines whether to accept the use of the corresponding bandwidth.

The power constraint subfield **652** indicates transmission power about the bandwidth indicated by the request bandwidth subfield **651** or requesting channels.

FIG. **7** shows the format of the CTS frame used in the exemplary embodiment of FIG. **5** by way of example.

The CTS frame **700** includes a frame control field **710**, a duration time field **720**, a receiver address field **730**, an FCS field **760** and a WS control field **750**.

The transmission channel control field **750** indicates control information about the responding channels available to the STA **510** or the responding channel over which the CTS frame can be transmitted. The transmission channel field **750** may include a status code subfield **751** denoting whether to accept the use of the requesting channels requested by the RTS frame **600**, and a responding bandwidth subfield **752** indicating a bandwidth of the transmission channel recommended to be used by the STA **510**.

If the status code subfield **751** indicates acceptance of the channels requested by the STA **510**, it may be set up that the bandwidth indicated by the responding bandwidth subfield **752** is equal to the bandwidth indicated by the request bandwidth subfield **651**.

The responding bandwidth subfield **752** indicates a bandwidth of an available responding channel. At this time, the recommended bandwidth subfield **752** may be set to indicate a bandwidth of 5 MHz as a default value. Further, the responding bandwidth subfield **752** may indicate bandwidth about a plurality of channels.

The responding bandwidth subfield **752** may indicate a bandwidth of the responding channels over which the CTS frame **700** is transmitted. For example, it is assumed that two CTS frames are respectively transmitted over two responding channels and a bandwidth of each responding channel is 20 MHz. The responding bandwidth subfield **752** may indicate 40 MHz.

The transmission channel control field **750** may further includes a power constraint subfield **753** indicating available transmission power when the bandwidth, indicated by the responding bandwidth subfield **752**, is used.

Thus, the STA **510** uses the status code subfield **751** for ascertaining whether the use of the frequency band is accepted or not when receiving the CTS frame **700** from the AP **520**, and uses the corresponding frequency band if the use is accepted. If the status code subfield **751** indicates denial of the occupation request, the STA **510** uses another frequency bandwidth.

The STA **510** can use the bandwidth of the responding channels which CTS frame is received over.

For a time indicated by the duration time field **620** of the RTS frame **600**, a network allocation vector (NAV) is set up with regard to the bandwidth indicated by the request bandwidth subfield **651** in the BSS where the STA **510** is involved. Likewise, for a time indicated by the duration time field **720** of the CTS frame **700**, the NAV is set up with regard to the bandwidth indicated by the responding bandwidth subfield **752** in the BSS where the AP **520** is involved.

The transmission channel request field **650** and/or the transmission channel control field **750** may be achieved by not a separate field but utilizing reserved bits of the duration time fields **620** and **720**. That is, most significant bits (MSB), i.e., 2 bits of a bit **14** and a bit **15** among 16 bits occupied by the duration time fields **620** and **720** are used for indicating the bandwidth for the plurality of requesting channels and total bandwidth for one responding channel or the responding channels, respectively. Accordingly, a request-response mechanism between the STA and the AP can be achieved with regard to the transmission channel to be used.

As opposed to the foregoing embodiment, the RTS frame and the CTS frame may be defined and used as a new management frame in the request-response frame transmitting/receiving mechanism between the STA **510** and the AP **520**.

FIG. **8** shows a data frame transmitting method according to another exemplary embodiment of the present invention.

The CTS-to-self frame is the CTS frame **700** including the receiver address field **730** indicating an address of a device transmitting the CTS frame

If the AP transmits the data frame, the STA may receive the data frame on the basis of the channel bandwidth and power constraint involved in the transmission channel control field (S**820**).

The AP or the STA may regulate the bandwidth by transmitting the CTS-to-self frame even though there is no separate request.

FIG. **9** shows a data frame transmitting method according to still another exemplary embodiment of the present invention.

The STA transmits a bandwidth switch request frame for requesting a switch of the bandwidth (S**910**).

The AP transmits a bandwidth switch response frame in response to the bandwidth switch request frame (S**920**).

FIGS. **10** and **11** are block diagrams showing the formats of the bandwidth switch request frame and the bandwidth switch response frame.

The bandwidth switch request frame **1000** includes a category field **1010** indicating the type or name of a corresponding frame, an action field **1020** indicating an action of the corresponding frame, a receiver address field **1030** indicating the MAC address of the wireless apparatus that receives the frame, and a transmitter address field **1040** indicating the MAC address of the wireless apparatus that transmits the frame. The bandwidth switch request frame **1000** includes a request bandwidth field **1050** indicating a bandwidth of a transmission channel desired to be used by the STA. This is the same as the request bandwidth field **651** of the foregoing RTS frame **600**, and thus repetitive descriptions thereof will be avoided.

The bandwidth switch response frame **1100** includes a category field **1110**, an action field **1120**, a receiver address field **1130**, and a transmitter address field **1140**. The bandwidth switch response frame **1100** may includes a status code field **1150** indicating whether the use of the transmission channel bandwidth indicated by the transmitted request bandwidth field **1050** is accepted, and a responding bandwidth field **1160** indicating a transmission channel bandwidth requested to be used by the STA **510**.

Further, the bandwidth switch response frame **1100** may include a power constraint field **1170** indicating transmission power available for transmitting the data frame in the case where the bandwidth indicated by the recommended bandwidth field **1160** is used. The above three fields are the same as the status code subfield **751**, the responding bandwidth subfield **752** and the power constraint subfield **753** of the foregoing CTS frame **700**, respectively, and thus repetitive descriptions thereof will be avoided.

FIG. **12** is a flowchart showing a bandwidth regulating method according to another exemplary embodiment of the present invention.

The AP **1220** sends the STA **1210** a bandwidth switch announcement frame including information about a transmission channel bandwidth desired to be used (S**1210**). The STA

1210 transmits the data frame through the transmission channel bandwidth (S1220). FIG. 12 shows an example that the bandwidth switch announcement frame is transmitted by the AP 1220, but not limited thereto. Alternatively, STA 1210 may transmit the bandwidth switch announcement frame and the data frame.

FIG. 13 is a block diagram showing the format of the bandwidth switch announcement frame used in the exemplary embodiment of FIG. 12.

The bandwidth switch announcement frame 1300 includes a category field 1310 indicating the type or name of a corresponding frame, an action field 1320 indicating an action of the corresponding frame, a bandwidth switch announcement element field 1230 indicating a transmission channel bandwidth desired to be used, and a power constraint field 1340 indicating constraint of power to be used in the transmission channel bandwidth.

The bandwidth switch announcement element field 1330 includes an element ID subfield 1331 indicating that a corresponding field is a bandwidth switch announcement element field, a length subfield 1332 indicating the length of the bandwidth switch announcement element field 1330, a bandwidth switch mode subfield 1333 for signaling whether the action of the STA 510 that receives the bandwidth switch announcement frame is constrained or not, a target bandwidth subfield 1334 indicating the transmission channel bandwidth desired to be used, and a bandwidth switch count subfield 1335 indicating a time when the transmission channel bandwidth, indicated by the target bandwidth subfield 1334, is switched.

The bandwidth switch announcement frame 1300 transmitted from the AP 1220 to the STA 1210 may be defined as a separate management frame. Also, a beacon frame or a probe response frame may be employed as a bandwidth switch announcement frame 1300.

As well known, the beacon frame is cyclically broadcasted at beacon intervals. If the beacon frame is used, the transmission channel bandwidth may be regulated semi-statically within a transmission interval.

FIG. 14 shows an example of bandwidth management information included in the beacon frame.

The beacon frame includes a bandwidth switch field 1400. The bandwidth switch field 1400 includes an element ID field 1410 indicating bandwidth switch information, a length field 1420 indicating the length of the bandwidth switch field 1300, and at least one transmission channel bandwidth vector field 1430, 1440, 1450 indicating management information about each transmission channel. Here, the three transmission channel bandwidth vectors are included in the bandwidth switch field 1400, but not limited thereto. Alternatively, one or more than three transmission channel bandwidth vectors may be included in the bandwidth switch field 1400.

The transmission channel bandwidth vector field 1430 includes a transmission channel bandwidth subfield 1431, an operation offset subfield 1432, an operation duration subfield 1433, and an operation interval subfield 1434.

The transmission channel bandwidth subfield 1431 indicates a bandwidth of an available transmission channel bandwidth.

The operation offset subfield 1432 indicates a start time of operating in the corresponding bandwidth.

The operation duration subfield 1433 indicates a duration time of operating in the corresponding bandwidth.

The operation interval subfield 1434 indicates an interval at which a new operation duration is initiated again after the duration time of operating in the corresponding bandwidth is elapsed. One operation cycle is defined on the basis of the operation duration subfield 1433 and the operation interval subfield 1434.

FIG. 15 shows an example of operation that can be performed in an exemplary embodiment of the present invention. For the convenience of the explanation, an operation in WS frequency band will be described by way of example. Let the maximum available transmission channel bandwidth be 10 MHz in consideration of an incumbent user using opposite edges of unoccupied frequency band.

The beacon frame is cyclically transmitted, and includes the transmission channel bandwidth vector field 1430. The transmission channel bandwidth subfield 1431 of the transmission channel bandwidth vector field 1430 indicates a bandwidth of 5 MHz.

After receiving the beacon frame, the operation duration of the STA is initiated using the bandwidth of 5 MHz at a time indicated by the operation offset subfield 1432 within the transmission channel bandwidth vector field 1430.

The operation duration continues during the duration time of the operation duration subfield 1433, and the STA uses the bandwidth of 10 MHz during the duration time indicated by the operation interval subfield 1434.

Bandwidth regulation is supported by a time division multiplexing (TDM) method within the beacon interval, and the beacon frame may be transmitted with the same bandwidth as the bandwidth indicated by the transmission channel bandwidth subfield 1431 of the transmission channel bandwidth vector field 1430 so as to transmit information about such transmission channel bandwidth regulation as being involved in the beacon frame.

In the meantime, even though the STA is signaled by the AP for information about the transmission power and the bandwidth of the transmission channel to be used for transmitting a data frame, i.e., a physical protocol data unit (PPDU), successful receipt of the AP has to be ensured by a higher level with respect to a specific portion of the data frame. That is, if a physical layer convergence procedure (PLCP) header of the PPDU frame transmitted by the AP and/or the STA is transmitted with low transmission power, another AP and/or STA at a coverage edge of the AP and/or the STA may not receive the corresponding PLCP header. Accordingly, the AP and/or the STA may not correctly perform channel clear assessment (CCA) detection.

FIG. 16 shows a format of a PPDU frame in the WLAN, which may refer to a paragraph 17.3.2 of "Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications" in IEEE P802.11-2007.

A PPDU frame 1600 includes a physical layer control procedure (PLCP) preamble 1610, a signal field 1620, and a data field 1630.

The PLCP preamble 1610 includes a symbol of the PPDU frame, and a training sequence for timing synchronization.

The signal field 1620 includes a rate field 1621, a reserve field 1622, a length field 1623, a parity field 1624, and a tail field 1625 of the PLCP header 160. The signal field 1620 may be transmitted in one orthogonal frequency division multiplexing (OFDM) symbol.

The rate field 1621 indicates a data rate.

The length field 1623 may indicate a number of octets of a data field 1630, a PPDU frame 1630 to be transmitted, or a PSDU 1632 that the MAC layer currently requests the physical layer to transmit.

The parity field 1624 is a field indicating a parity bit for preventing an error of data. The data field 1630 includes a service field 1631, a PSDU 1632 and a tail field 1633 of the PLCP header 160. Also, the data field 1630 may further include a padding field **1634** for padding the octet of the PPDU frame **1600**. The service field **1631** is used for initializing a scrambler.

In the WLAN system, the frame transmitted and/or received by the STA and/or the AP has the foregoing form of the PPDU frame **1600**. The PPDU frame **1600** is transmitted through a plurality of OFDM symbols.

As described above, even if a transmission channel bandwidth to be used in transmitting the data frame is signaled, the transmission power may be constrained when using the bandwidth. At this time, the STA and/or the AP may not receive the PLCP header (more specifically, a signal field on the structure of the PPDU frame). Accordingly, there is proposed a method of fully ensuring that the PLCP header is transmitted using a basic transmission channel (5 MHz bandwidth) with the maximum transmission power in light of transmitting the data frame through the signaled transmission channel bandwidth

FIG. **17** shows a method of transmitting a data frame according to an exemplary embodiment of the present invention. Here, the data frame refers to a PPDU frame transmitted in the physical layer of the WLAN system.

The PLCP header and the data field of the PPDU frame may be transmitted using different transmission power in different frequency bands. Below, the frequency band used for transmitting the PLCP header will be called a first transmission channel **1710**, and the frequency band used for transmitting the data field will be called a second transmission channel **1720**.

The bandwidth of the first transmission channel **1710** is fixed, but the bandwidth of the second transmission channel **1720** is variable. The bandwidth of the first transmission channel **1710** may be narrower than that of the second transmission channel **1720**. The bandwidth of the first transmission channel **1710** may be fixed to 5 MHz, which is for fully ensuring the maximum transmission power in light of transmitting the PLCP header through the first transmission channel **1710**.

The second transmission channel **1720** may have a specific bandwidth of the unoccupied frequency band announced through the DB access or the spectrum sensing result implemented by the STA or the AP.

The second transmission channel **1720** may have the bandwidth of the transmission channel signaled as described above with FIGS. **5** to **15**.

Referring to FIGS. **5** to **7**, in the case where the transmission channel bandwidth of the data frame is signaled by transmitting and receiving the RTS-CTS frames, if a status code **751** indicates admission, the bandwidth of the second transmission channel may be a bandwidth indicated by a request bandwidth subfield **651** of the transmission channel request field **650**. If the status code **751** indicates refusal, the bandwidth of the second transmission channel may be a bandwidth indicated by the responding bandwidth subfield **752** of the transmission channel control field **750**.

Referring to FIG. **8**, a bandwidth indicated by the transmission channel control field of a CTS-to-Self frame may be used as the bandwidth of the second transmission channel.

Referring to FIGS. **9** to FIG. **11**, in the case where the transmission channel bandwidth is signaled by transmitting and receiving a bandwidth switch request frame and a bandwidth switch response frame, if a status code **1150** indicates acceptance, the bandwidth of the second transmission channel may be a bandwidth indicated by a request bandwidth field **1050**. If the status code **1150** indicates refusal, the bandwidth of the second transmission channel may be a bandwidth indicated by responding bandwidth field **1160**.

Referring to FIGS. **12** and **13**, if the transmission channel bandwidth is signaled by transmitting a bandwidth switch announcement frame, the bandwidth of the second transmission channel may be a bandwidth indicated by a target bandwidth subfield **1334**.

Referring to FIGS. **14** and **15**, if the transmission channel bandwidth is signaled by a beacon frame including a channel bandwidth vector field, the bandwidth of the second transmission channel may be a bandwidth indicated by each channel bandwidth sub field of the bandwidth vector fields **1430**, **1440** and **1450**.

Referring to FIG. **17**, the STA and/or the AP transmits a PLCP preamble **1810** and a PLCP header **180** (more specifically, a signal field **1820**) through a first transmission channel **1710** having a bandwidth of 5 MHz with respect to a center frequency fc.

A data field **1830** is transmitted through a second transmission channel **1720** having a bandwidth equal to or wider than that of the first transmission channel **1710**. The bandwidth of the second transmission channel **1720** may have 5 MHz, 10 MHz, 20 MHz or more, which are all multiples of 5.

Although the STA and/or the AP can use a higher bandwidth, the bandwidth used in transmitting the PLCP header **180** is limited to the bandwidth of 5 MHz. This is to guarantee successful receipt of a receiver by transmitting the PLCP header **180** with power as high as possible.

Because the first transmission channel **1710** and the second transmission channel **1720** are different in the bandwidth, they may also be different in the transmission power. For example, while the transmission power for the PLCP header **180** is 100 mW, the transmission power for the data field **1830** may be 40 mW.

If a receiver is placed at a coverage edge of a transmitter, the receiver can receive the PLCP header **180** but cannot receive the data field **1830** since no signal is sensed in the channel. Although no signal is sensed, the receiver can determine that the second transmission channel **1720** is being occupied, on the basis of the frame length information of the PLCP header **180**.

A transition gap **1730** may be provided between the PLCP header **180** and the data field **1830**. Since a sampling frequency and a sampling rate are changed between the first transmission channel **1710** and the second transmission channel **1720**, the transition gap **1730** is provided for allowing a receiver to be tuned to a widened bandwidth. If the receiver is operated at the sampling rate supported as highest as possible, there may be no need of such a transition gap.

FIG. **18** is a block diagram showing the format of the PPDU frame according to an exemplary embodiment of the present invention.

The PPDU frame **1800** includes a PLCP preamble **1810**, a signal field **1820**, and a data field **1830**.

The PLCP preamble **1810** is used for synchronization. In the WLAN system, the PLCP preamble **1810** includes twelve OFDM symbols for various timer synchronizations between the transmitter and the receiver. Among them, ten symbols are short training symbols, and the other two symbols are long training symbols.

The signal field **1820** includes a rate field **1821**, a length field **1822**, a parity field **1823**, a tail field **1824**, a bandwidth field **1825**, and a transmission power field **1826** of the PLCP header **180**.

The rate field **1821**, the length field **1822**, the parity field **1823** and the tail field **1824** have the same functions as the fields **1621**, **1623**, **1624** and **1625** of FIG. **16**, respectively.

The bandwidth field **1825** shows the bandwidth of the second transmission channel **1720**. If the bandwidth of the second transmission channel **1720**, i.e., the transmission bandwidth for the data field **1830** is signaled to the PLCP header **180**, sub-carrier spacing of the PSDU **1832** is determined on the basis of this signaling information.

The transmission power field **1826** shows a transmission power constraint of when the second transmission channel **1720** is used. The maximum transmission power value indicated by the transmission power field **1826** may be the maximum transmission power indicated by the power constraint sub-fields **652**, **753** and the power constraint fields **1170** and **1340** of the exemplary embodiments as described above with reference to FIGS. **5** to **15**.

The data field **1830** includes a service field **1831**, a PSDU **1832**, a tail field **1833** and a pad field **1834** of the PLCP header **180**. Here, the tail field **1833** and the pad field **1834** have the same functions as the tail field **1633** and the padding field **1634** of FIG. **16**, respectively.

The data field **1830** is encoded in accordance with a data rate and scrambled before being transmitted.

The service field **1831** is included in the PLCP header **180**, but transmitted as being included in the data field **1830** of the PPDU frame **1800** when transmitted. This is to initialize the scrambler.

The format of the PPDU frame **1800** is nothing but an example. The name or location of each field may be changed. Also, a certain field of the PPDU frame **1800** may be omitted, and another field may be added.

FIG. **19** is a block diagram of a wireless device to implement the present invention. The wireless device **1900** may be a part of a STA or an AP or may be a part of a transmitter or a receiver.

The wireless device **1900** includes an interface unit **1910** and a processor **1920**. The interface unit **1910** is operatively coupled with the processor **1920** and provides a wireless interface with other wireless device. The processor **1920** implements functions of the STA or AP shown in embodiments of FIGS. **2**, **5**, **8**, **9** and **12**. The processor **1920** may perform the bandwidth adaptation.

The processor may include application-specific integrated circuit (ASIC), other chipset, logic circuit and/or data processing device. The memory may include read-only memory (ROM), random access memory (RAM), flash memory, memory card, storage medium and/or other storage device. When the embodiments are implemented in software, the techniques described herein can be implemented with modules (e.g., procedures, functions, and so on) that perform the functions described herein. The modules can be stored in memory and executed by processor. The memory can be implemented within the processor or external to the processor in which case those can be communicatively coupled to the processor via various means as is known in the art.

In view of the exemplary systems described herein, methodologies that may be implemented in accordance with the disclosed subject matter have been described with reference to several flow diagrams. While for purposed of simplicity, the methodologies are shown and described as a series of steps or blocks, it is to be understood and appreciated that the claimed subject matter is not limited by the order of the steps or blocks, as some steps may occur in different orders or concurrently with other steps from what is depicted and described herein. Moreover, one skilled in the art would understand that the steps illustrated in the flow diagram are not exclusive and other steps may be included or one or more of the steps in the example flow diagram may be deleted without affecting the scope and spirit of the present disclosure.

What is claimed is:

1. A method of requesting a channel access in a wireless local area network, the method comprising:

generating, by a transmitter, a 20 MHz Request To Send (RTS) frame, the 20 MHz RTS frame including requesting bandwidth information indicating a first bandwidth;

duplicating, by the transmitter, the 20 MHz RTS frame one or more times to generate at least one duplicated 20 MHz RTS frame, each duplicated 20 MHz RTS frame including the requesting bandwidth information;

transmitting, by the transmitter, the 20 MHz RTS frame over a 20 MHz requesting channel;

transmitting, by the transmitter, the at least one duplicated 20 MHz RTS frame over the at least 20 MHz duplicated requesting channel, respectively; and

receiving, by the transmitter, at least one 20 MHz Clear To Send (CTS) frame as a response to at least one of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame, each 20 MHz CTS frame including responding bandwidth information indicating a second bandwidth,

wherein the first bandwidth is 20×(n+1) MHz to indicate an entire transmission bandwidth for the 20 MHz requesting channel and the at least one 20 MHz duplicated requesting channel, and

wherein n is a positive number of the at least one duplicated 20 MHz RTS frame.

2. The method of claim **1**, wherein the at least one 20 MHz CTS frame is at least one among a 20 MHz CTS frame and zero or more duplicated 20 MHz CTS frame transmitted over the second bandwidth.

3. The method of claim **1**, wherein:

the second bandwidth is 20×(m+1) MHz; and

m is a number of zero or more duplicated 20 MHz CTS frame.

4. The method of claim **3**, wherein each of the 20 MHz CTS frame and the zero or more duplicated 20 MHz CTS frame is transmitted over a respective 20 MHz channel within the second bandwidth.

5. The method of claim **1**, wherein the second bandwidth is equal to or less than the first bandwidth.

6. The method of claim **5**, wherein, when the first bandwidth indicated by the first bandwidth information is 40 MHz, the second bandwidth indicated by the second bandwidth information is 20 or 40 MHz.

7. The method of claim **5**, wherein, when the first bandwidth indicated by the first bandwidth information is 80 MHz, the second bandwidth indicated by the second bandwidth information is 20 or 40 or 80 MHz.

8. The method of claim **5**, wherein, when the first bandwidth indicated by the first bandwidth information is 160 MHz, the second bandwidth indicated by the second bandwidth information is 20 or 40 or 80 or 160 MHz.

9. The method of claim **1**, wherein:

each of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame is processed based on a first bit sequence; and

the first bit sequence indicates a generating characteristic of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame.

10. The method of claim **9**, wherein two bits of the first bit sequence are used for the first bandwidth information.

11. The method of claim **9**, wherein:

each of the at least one 20 MHz CTS frame is processed based on a second bit sequence; and

the second bit sequence indicates a generating characteristic of the at least one 20 MHz CTS frame.

12. The method of claim 11, wherein two bits of the second bit sequence are used for the second bandwidth information.

13. A device configured to request a channel access in a wireless local area network, comprising:

a wireless interface unit; and

a controller operatively connected to the wireless interface unit and configured to:

generate a 20 MHz Request To Send (RTS) frame, the 20MHz RTS frame including requesting bandwidth information indicating a first bandwidth;

duplicate the 20 MHz RTS frame one or more times to generate at least one duplicated 20 MHz RTS frame, each duplicated 20 MHz RTS frame including the requesting bandwidth information;

transmit the 20 MHz RTS frame over a 20 MHz requesting channel;

transmit the at least one duplicated 20 MHz RTS frame over the at least 20 MHz duplicated requesting channel respectively; and

receive at least one 20 MHz Clear To Send (CTS) frame as a response to at least one of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame, each 20 MHz CTS frame including responding bandwidth information indicating a second bandwidth,

wherein the first bandwidth is 20×(n+1) MHz to indicate an entire transmission bandwidth for the 20 MHz requesting channel and the at least one 20 MHz duplicated requesting channel, and

wherein n is a positive number of the at least one duplicated 20 MHz RTS frame.

14. The device of claim 13, wherein the at least one 20 MHz CTS frame is at least one among a 20 MHz CTS frame and zero or more duplicated 20 MHz CTS frame transmitted over the second bandwidth.

15. The device of claim 13, wherein:

the second bandwidth is 20×(m+1) MHz; and

m is a number of zero or more duplicated 20 MHz CTS frame.

16. The device of claim 15, wherein each of the 20 MHz CTS frame and the zero or more duplicated 20 MHz CTS frame is received in response to both of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame.

17. The device of claim 13, wherein the second bandwidth is equal to or less than the first bandwidth.

18. The device of claim 17, wherein, when the first bandwidth indicated by the first bandwidth information is 40 MHz, the second bandwidth indicated by the second bandwidth information is 20 or 40 MHz.

19. The device of claim 17, wherein, when the first bandwidth indicated by the first bandwidth information is 80 MHz, the second bandwidth indicated by the second bandwidth information is 20 or 40 or 80 MHz.

20. The device of claim 17, wherein, when the first bandwidth indicated by the first bandwidth information is 160 MHz, the second bandwidth indicated by the second bandwidth information is 20 or 40 or 80 or 160 MHz.

21. The device of claim 13, wherein:

each of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame is processed in basis of a first bit sequence; and

the first bit sequence indicates a generating characteristic of the 20 MHz RTS frame and the at least one duplicated 20 MHz RTS frame.

22. The device of claim 21, wherein two bits of the first bit sequence are used for the first bandwidth information.

23. The device of claim 21, wherein:

each of the at least one 20 MHz CTS frame is processed based on a second bit sequence; and

the second bit sequence indicates a generating characteristic of the at least one 20 MHz CTS frame.

24. The device of claim 23, wherein two bits of the second bit sequence are used for the second bandwidth information.

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